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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

MARCH 17.

Institute of Metals (Birmingham Local Section):—Ordinary meeting. "The Metallurgy of Some of the Rarer Metals," Paper by C. J. Smithells, M.C., D.Sc.

Institute of British Foundrymen.

MARCH 14.

Scottish Branch (Falkirk Section):—Annual general meeting at Falkirk. Discussion on "Foundry Problems."

Wales and Monmouth Branch:—Ordinary meeting at Newport. "Non-Ferrous Alloys," Paper by Wm. Williams.

MARCH 19.

London Branch:—Ordinary meeting in London. "Some Practical Notes on Foundry Sands," Paper by J. L. Francis.

Rules of Debate.

The Sheffield Section of the Institute of British Foundrymen has launched a debating society for the benefit of its members, and we know of no movement more likely to be helpful to the personnel of the industry, providing that clarity of expression is the object sought. Current modes of expression are often, on analysis, of an indefinite character. It is quite normal, for instance, for foundrymen to say "the first tap was cold," when meaning that "the metal from the first tap was cold." Again, it is not uncommon, surprising though it may sound, for "a mould" to be called "a casting," especially when referring to such questions as running and gating. "Ramming up boxes," "slagging ladles," "pouring castings," and "casting a job" are typical of the slip-shod phraseology of the foundry.

Another "rule of debate" which is applicable to foundry discussions is the sound objection to arguing from the "particular" to the "general," and one of the main functions of both the Institute, as a body, and this JOURNAL, as an instrument for the dissemination of specialised knowledge, is to discover the generally applicable fundamental material from localised peculiarities.

Another rule of debate which could be usefully applied to some foundry discussions is the necessity of addressing remarks to the chairman and through him to the "house." We frequently find members of the audience indulging in short arguments with the lecturers.

Whilst we would deplore too much restraint by Branch chairmen, as possibly restricting free discussion, we think that by maintaining something of the rules of debate, more orderly and generally applicable information would be forthcoming, even if the quantity were less. For the benefit of the industry in general, and for the help of the lecturer in particular, chairmen would be well advised to disallow bad cases of description such as "the neglect to perform certain operations results in the production of waster castings," or "the mould was cast quickly with good hot metal." It is within the power of almost any foundryman to describe the nature of a "waster," whilst we expect that all grades including and superior to that of a charge hand should be in a position to detail the weight of the casting and the elapsed time for filling the mould. So far as the "good, hot" is concerned, that should be allowed to pass unless the speaker is a trained metallurgist familiar with temperatures and possessing a knowledge of composition and viscosity.

We must all remember that until the adjectives of the kitchen cease to be applied to the foundry the exchange of reliable technical information will only be possible between skilled scientists. Such expressions as "good," "bad," "hot," "cold," "thick," "thin," "heavy" and "light," used alone, become more vague every year with the complication of industry. The artificial standards based on the above descriptions created in each shop or district are not nationally applicable and carry too wide an interpretation to be of real value locally. We look forward to the time when debating societies will be organised in connection with all branches of the Institute, as they have an unusual scope by rendering articulate the personnel of the industry.

Smelting and Remelting.

The views expressed by Mr. J. E. Fletcher in a Paper now published in our columns emphasise a point of view to which we have previously given some attention, and that is the importance to the British founding industry of the small and medium-size blast furnace. The economic tendency to-day is all in the direction of the large furnace, and, as is pointed out, a mere handful of thousand-tons-a-day plants would suffice to supply the whole of the British market. The founder badly needs pig-iron at the price at which it can be produced in the large furnace. But will he be wholly satisfied with the quality? We think that the success of refined iron is sufficient to answer this question in the negative, for the pig-iron refiner has grown since the advent of the big furnace, and his success is largely in the direction of overcoming the major disadvantages of the iron from the big type of furnace. Economic conditions are squeezing out the small furnace, but we think that British founders will be sorry when they no longer have them to draw on—as will those German and American and other foreign buyers who have found out by experience the virtues of the iron made in them.

We need not follow the author into his explanation of the reasons for the differences, for they are well known to and appreciated by founders as a whole, and it is evident enough that a small furnace will involve a smelting cost per ton of metal produced, or, in the case of a cupola, a remelting cost, larger than that of the large blast furnace. The former applies even more to the cold-blast furnace than to the small

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and slowly-driven furnace working with a moderate blast temperature.

There is little doubt, in our experience, that the quality of pig-iron produced in the large furnace creates problems for the ironfounder which more and more necessitate his having technical advice at his disposal. The future may well enable the metallurgist to use these irons as satisfactorily as the others, for it would be very unwise to deny the possibility of progress in any direction. But one of the difficulties of the situation is that as yet we cannot say what the difference between the two types is and how it arises, any more than we can say how the difference arises between hot- and cold-blast iron. Consequently the maker using the small furnace is unable to point to any test result or condition which justifies his charging the higher price to which he is entitled. Founders should keep in mind all the time that the big furnace is mainly intended for the production of steel-making pig, and that foundry pig, while cheaper from such furnaces than from the smaller ones,, may involve him in radical departures in foundry practice in future. This fact should be made clear to all owners and works managers by foundrymen, where the production of high-class castings is required.

A New Alloy.

After many years of experimenting, a Gateshead metallurgist, Mr. William J. Campbell, managing director of the Gateshead Foundry Company, Limited, has invented a new metal known as "Steelite," which is claimed to be superior to ordinary cast steel for hard wear and withstanding heat. It is further claimed that "Steelite" can reduce running costs for collieries, as rollers, drums, sheaves and tub bearings made of the new metal have been tried with satisfactory results. Moreover, several White Star liners are soon to be fitted with crude-oil-burning apparatus of "Steelite."

The Gateshead Foundry is now specialising in the production of the alloy for colliery drums and other fittings, while its use has been extended to castings of large dimensions. It is stated that the alloy can be produced 50 per cent. cheaper than Sheffield manganese steel and much more quickly, and its structure is of a pearlitic-iron character but with a closer grain, and has the property of withstanding excessive heat without any appreciable grain growth.

Notes from I.B.F. Branches.

Newcastle Branch.—Forty-five candidates participated in the junior section of the John Surtees Memorial Competition in January. The theoretical portion of the examination was conducted at the Rutherford Technical College, whilst the practical portion was held in the Technical Class Foundry at Walker Gate; in the latter the apprentices were examined orally in sand moulding, loam moulding, coremaking, furnaces, moulding sands and facings, and also given written questions on general practical work. The first six prizewinners have been declared by the Governors as follow:—*1st Prize, Silver Medal and Book.*—T. Brass, apprentice moulder at Messrs. Armstrong, Whitworth & Company, Limited, Close Works, Gateshead. *2nd Prize.*—James Mills, apprentice moulder at Messrs. Carmichael Bros., Limited, Nile Street, South Shields. *3rd Prize.*—W. Turnbull, apprentice moulder at Messrs. Armstrong, Whitworth & Company, Limited, Close Works, Gateshead. *4th Prize.*—J. Smith, apprentice moulder at the Wallsend Slipway & Eng. Company, Limited, Wallsend. *5th Prize.*—H. Vasey, apprentice moulder at the North Eastern Marine Eng. Company, Limited, Wallsend. *6th Prize.*—G. Metcalfe, apprentice moulder at Messrs. Swan, Hunter & Wigham Richardson, Limited, Wallsend.

Institute of British Foundrymen.

A COMING-OF-AGE CELEBRATION.

On February 16 the Scottish Branch of the Institute of British Foundrymen completed its twenty-first year. The Branch Council determined to mark the occasion by holding a social function to inaugurate a propaganda campaign, with the object of making more widely known the activities of the Institute and also of securing the interest and co-operation of the principals of firms and their employees in the foundry industry who might reasonably be expected to become members of the Institute but have not yet done so. In furtherance of this campaign members of the Scottish Council are undertaking a personal canvass of prospective members and subscribing firms with a view of explaining to them the advantages of membership of the Institute.

In view of the meeting of the General Council in Glasgow on April 18 it has been decided to hold the celebrations at that time. The Corporation of Glasgow has agreed to extend civic hospitality to the members and friends of the Scottish Branch and of the General Council at a reception to be held in the City Chambers on the evening of Friday, April 17.

As a permanent record of the achievements of the Scottish Branch during the past 21 years, more particularly in respect of its efforts on behalf of the younger members and apprentices, the local Council have decided to place at the disposal of the Education Committee a capital sum, the interest on which is to be applied to the provision of a prize, which will be competed for by students attending the classes in foundry practice. Further particulars of the celebrations will be given at a later date.

Old-Established Foundry to be Dismantled.

In the course of the next few weeks the machinery and plant of the old-established business of the Anderston Foundry Company, Limited, will be dismantled and auctioned. The decision to discontinue the works in Glasgow is largely due to the prolonged depression in textile machinery and other products of the company. The Middlesbrough works, which are principally employed in the production of permanent-way material, will be continued.

The Anderston Foundry was established in 1798, the period of the Napoleonic wars, and old members of the firm claimed that its birth was in the year Nelson won the Battle of the Nile. In 1884 the present company was registered, and has produced, among other things, textile machinery, vacuum-pumping engines and compressors and wire-weaving machines.

Advertising Cast Iron.

A lecture of a novel character was given before the French Foundry Technical Association at its last meeting by Mr. Yves Colombot, who pleaded for the establishment in France of a co-operative bureau of information on cast iron. He referred to the success achieved by the Bureau International de l'Aluminium; Centre d'Information du Nickel; Office Technique d'Utilisation de l'Acier (steel products development bureau), and the Bureau d'Information du Molybdène, all of which have the counterparts in England.

Mr. Ronceray, proposing a vote of thanks, said that efforts so far made for popularising malleable in France had been crowned with success.

Random Shots.

A popular figure in the foundry industry, who has been something of an *habitué* of the West End for the past ten years, tells me that Monday was the first occasion on which he had seen a smooth unbroken covering of snow upon the Strand. The fall was sufficiently heavy to obliterate the wheeltracks of the innumerable vehicles passing along this thoroughfare. And the four colossal lions in Trafalgar Square, usually so black and grim in appearance, might have been of white marble, fresh from the sculptor's chisel. Over 1,000 additional helpers were engaged in clearing the streets, payment being at the rate of 1s. 2d. per hour, so it is an ill-wind . . .

* * *

The theatre has of late been in the limelight of public attention. That it is experiencing one of the worst slumps within living memory is due not so much to celluloid competition or to lack of patronage as to the abundance of definitely weak or bad plays which recently have been produced. When one considers that the rent of a not-palatial West End theatre is in the region of £500 or £600 weekly, and that a "flop" may cost anything over £3,000 in rehearsals, properties and salaries alone, it is quite obvious that a company cannot stay in business sufficiently long to put on many failures. No amount of publicity can make a bad play a financial success, but when a "winner" does appear the public very readily supports it. "Bitter Sweet," "Ever Green," "It's a Boy," "The Barretts of Wimpole Street," and "Jane's Legacy" afford proof of that statement.

* * *

Speaking of theatrical publicity reminds me of the story concerning a poorly-advertised production in a small provincial town. Half-way through the performance a small boy crept from the gallery to the box-office and demanded back his money.

"What's wrong? Don't you like the play?" demanded the young damsel therein.

"Well, the play's fine," he confessed, "but I'm scared of being up there all by myself!"

* * *

The Bank of England until recently held pride of place as the City's most grimy and ugly building. Now that the additions to its squat structure are nearing completion, its appearance has been considerably improved. Last week there were revealed to Londoners' curious eyes three handsome doors, constructed of what appears to be beaten bronze and decorated with a simple but effective design. In outward semblance they are artistic, but I half suspect that behind them is concealed a device which will psycho-analyse anyone approaching them and give warning against the felonious-minded. Such a magician's grotto is the Bank!

* * *

Commenting on "the perils of mass mania," an American business expert says that the "dinosaur was a first-class example of mass production. But he and his kind have all been quite dead for several million years because too much of their 'mass' was below their ears."

Marksman.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Malleable Cast Iron.

To the Editor of The Foundry Trade Journal.

Sir,—I have read with considerable interest the Paper on "The Manufacture and Properties of Malleable Castings," by Mr. Smithson, published in your issue of February 5, and feel there are possibly just one or two points that need special comment.

Speaking of the irons used, Mr. Smithson says "such irons are of two kinds, one direct from the blast furnace the other specially refined." He does not, however, continue the theme further and say which of these products yield the better castings, and the probable reasons for so doing.

In the malleable foundry a refined pig-iron is generally preferred, this choice being based on experience, having definitely proved that better and more consistent results are obtained therefrom than from the direct blast-furnace product. These improved results obtained by the use of refined irons are undoubtedly due to the following two factors:—(*a*) The lower total-carbon content and (*b*) the greater regularity and more uniform composition.

With regard to grading of pig-irons for the malleable industry, Mr. Smithson says "These irons are graded according to fracture, usually in six grades, and names descriptive of the fracture are given to each grade." In this connection, it may be of general interest to call your readers' attention to the fact that it is the custom of the firm with which the writer is connected to classify these irons in no less than ten grades, ranging in fracture from white to grey. It is found that this practice is essential in order to meet the requirements of the close limits of analysis desired in the malleable trade, and especially those founders who still have to judge the composition of iron by fracture alone.

Passing on to cupola practice, Mr. Smithson remarks:—"In order to keep the composition of the white castings within the narrow limits which are essential to successful annealing, it is essential to have two grades of pig-irons and introduce a proportion of the softer grade at frequent intervals to compensate for the unavoidable silicon loss." This question of silicon loss is, indeed, an important and vital factor to the malleable ironfounder, who is strongly urged to "read, mark, learn and inwardly digest" the information given in the Paper.

Owing to the large amount of scrap produced, there is always a strong tendency to use 50 per cent. or even more of this material on a charge. The use of such large amounts may, and in fact does, yield satisfactory castings for a short time, but will (unless the suggested precautions are taken) ultimately result in the production of a metal whose silicon content will be too low for successful annealing within the usual time and temperature limits. Experience proves that a scrap content not exceeding one-third of the weight of the charge is preferable generally.

Turning to the question of annealing, Mr. Smithson stresses the point of rate of heating of the ovens; but the equally important question of rate of cooling has apparently escaped his notice. Both these factors are of vital importance in the production of really good malleable. With too-rapid heating one is liable to get "peeled" castings, with overheating a coursing of the structure takes place, with its consequent reduction in strength, and with too-rapid cooling one obtains a rehardened casting, similar in structure (although modified) to a quenched steel. Under no circumstances should the furnace doors be opened until the contents have cooled to a black heat, and for preference to 550 deg. C. Beyond this stage they can, of course, be opened and the contents "dumped" without fear of any serious injury taking place.

In conclusion, there is just one other point to be mentioned, namely, the maximum phosphorus content is stated to be 0.2 per cent. This is obviously a clerical error, as 0.3 per cent. is the maximum amount of this element permissible.—Yours, etc.,

J. H. D. Bradshaw.

Messrs. Bradley & Foster, Limited,
Darlaston.

To the Editor of The Foundry Trade Journal.

Sir,—Mr. H. H. Shepherd is indeed to be highly congratulated upon his excellent Paper bearing the above title, recently published in your Journal. This Paper will undoubtedly prove of immense value to everyone interested in the malleable cast-iron industry, principally on account of the great amount of practical information and data contained therein.

Although the Paper is primarily intended as a description of the methods employed in the production of black-heart malleable, it is of extreme importance to point out that all the remarks apply probably with equal force to the manufacture of really good white-heart castings.

I whole-heartedly agree with Mr. Shepherd that the most important factor governing the success or failure in the manufacture of malleable castings is the composition of the metal, which must be of strictly uniform composition. In fact one may go further and say that in no metallurgical process do composition of metal, size of casting, temperature and duration of operations have to be kept within such fine limits as those demanded in the production of good malleable cast iron.

Another point one is glad to see mentioned in the Paper is the question of weighing all materials forming part of the charge. The full significance of this point is not even now realised in a large number of foundries, who still continue to work the cupola in a somewhat haphazard way.

I would also like to confirm Mr. Shepherd's statement that better results are obtained by working smaller charges on the cupola. Some years ago a small cupola was giving very erratic and unreliable results, especially when alloys, *e.g.*, ferro-silicon, had to be introduced into the charge. At the time the charge weighed 448 lbs. but was eventually reduced to 224 lbs., when it was found to give (1) extremely uniform results, (2) very hot metal, and (3) required less coke. The cupola was in use at a malleable iron foundry, and the bulk of the work was a very thin type requiring hot metal, which, by the way, was not always obtained when working the heavier charge. An additional disadvantage at the plant in question was the fact that the cupola was used without a receiver, the metal running direct from the cupola into the pouring ladles.

With regard to the question of annealing, one is pleased to observe the importance given to the rate of cooling. This is a vital factor in the production of really good malleable, and although Mr. Shepherd places this at a maximum of 7 deg. C. per hour, the writer prefers one of 5 deg. C. per hour, and steps taken to see that this is not exceeded when castings free from brittleness are required.

In conclusion, it is of interest to note that Mr. Shepherd uses one or two brands of hematite pig-iron together with two brands of refined iron. Owing to the technical control available, however, he is able to use a certain amount (25 per cent.) of steel scrap on his charge, which virtually converts the hematite into a refined iron. This method of using steel, however, demands far more technical control and better melting conditions than usually prevail in the normal malleable foundry, where more uniform results are unquestionably obtained by the exclusive use of refined pig-iron.—Yours, etc.,

J. H. D. Bradshaw.

Messrs. Bradley & Foster, Limited,
Darlaston,
February 26, 1931.

Belgian Sand and Steel Castings.

To the Editor of The Foundry Trade Journal.

Sir,—As very large importers of Belgian moulding sands we take exception to the imputation contained in an advertisement in your issue of March 5, namely, that we sell steel castings at dump prices in our spare time.

So far as my company is concerned, not only is the imputation grossly unfair, it is also a gross mis-statement and apt to injure our business, therefore we request that you give publicity to our denial of selling steel castings in our spare time at dump prices, as our sole interests are in the selling of our sands for the efficient and economical production of steel and iron castings.—Yours, etc.,

Anglo-Belgian Refractories,
Donald Pitt.

53, Solihull Lane,
Hall Green, Birmingham.
March 8, 1931.

Cast-Steel Diving Bell for Deep-Sea Operations.

A large steel ball, in which two investigators have been exploring the ocean depths off Nonesuch Island, Bermuda, to study undersea life on behalf of the New York Zoological Society, was built by the Atlas Steel Casting Company, Buffalo, and the Watson-Stillman Company, Aldene, N.J. The device, according to "The Iron Age," was made as a hollow-cored casting. Windows were of fused quartz. The quartz lenses were secured in counterbored recesses by means of glands. Thin sheet gaskets were used to make a pressure-tight job. Interior fittings included powerful electric lights, one on each side, and telephone and power connections with the surface craft. The bell also contains a source of oxygen supply and apparatus for removing impurities from the air.

In actual service the sphere has reached a depth of about 1,400 ft., where the water pressure was 43 atmospheres (650 lbs. per sq. in.) or a pressure of 1 ton on a 2-in. circle. The total collapsing pressure is 750 tons in all directions on the sphere. The bell was made of carbon cast steel without alloying elements. To ensure a sound casting, an extra number of risers were used. The tests made before it was put in service demonstrated that it would withstand all of the stress that would be placed upon it, with a sufficient margin of safety, as it was subjected to 900 lbs. per sq. in. external pressure and 2,000 lbs. internal pressure.

The weight of the sphere equipped is 6,600 lbs., the casting itself weighed 5,500 lbs. The inside diameter is 4 ft. 6 in., allowing ample room for two persons in sitting posture. The wall thickness is 1¼ in. The walls were left rough, both inside and out.

New Jib-Crane Regulations.—The Home Office has issued draft regulations for jib cranes to apply to all factories and workshops and other classes of premises coming under Section 79 of the Factory and Workshop Act, 1901. Copies of the draft regulations may be obtained on application to the Factory Department, Home Office, London, S.W.1. Any objections to them must reach the Secretary of State within 40 days from March 3, 1931, the date on which the notice was issued.

Foundry Selling Practice.

By Eric N. Simons.

(*Continued from page* 179.)

No. 1. SALES LETTERS—(*continued*).

It is obvious that a table of the sort outlined in last week's article could be extended indefinitely, but some at least of the more common errors in commercial correspondence have been indicated. The reader should bear in mind that many expressions which come readily to his mind when dictating or writing are also ugly, shoddy and vulgar expressions, which he will do well to avoid. Of this kind are "standpoint" for "point of view," "back number" for "antiquated," "fix up" for "arrange" or "organise," "anyway" for "at any rate" or "at all events," "just fine" for "very good," "a sure thing" for "a certainty," "a let-down" for "a disappointment," "turned down" for "refused" or "rejected."

Brevity is important. Whilst everybody appreciates a well-expressed letter, nobody—at least in commerce—wishes his post to be filled with flowery and copious dissertations. (A letter can consist of three lines and be well expressed.) It is necessary not to confuse brevity with curtness. The reader of the letter should not be made to think that the writer has not time to bother with him. Modern usage has, however, considerably simplified the task of the letter writer who wishes to be brief without being abrupt. It is now a recognised practice in up-to-date commercial correspondence to omit a good many of the circumlocutions that, without serving any real purpose, cluttered up the letters of business firms some twenty or more years ago. It is no longer necessary, for example, to begin with this venerable phrase: "We are in receipt of your letter of the 27th ult." It is sufficient to write: "Your letter of the 27th June." (Modern practice is to avoid "ult." and "prox." and similar Latinisms, and to state clearly the type of communication—letter, post-card, telegram—and the name of the month.) That sentence gives all that is necessary, and saves time without in any way giving offence. Similar clumsy circumlocutions are: "We beg to acknowledge receipt of your esteemed favour of" and "This is to acknowledge safe receipt of your esteemed communication of." These are all obsolescent.

In the same way, letters are seldom ended: "We beg to remain, your most obedient servants." Few up-to-date modern commercial houses "beg" anything in their letters. "We are, yours faithfully," is the current standard form of words. It says enough.

Sincerity is essential in all good letter-writing, but more will be said on this point when the writing of direct sales letters is discussed.

A good deal of stereotyped nonsense has been drilled into business men during their school days by pedants, with the idea that a formal rule can of itself lead to good English, and suffice for all eventualities. One of these stupid rules of thumb is, that a sentence should never end with a preposition. As a fact, it is one of the glories of the English language that it is flexible enough to allow of a sentence ending in a preposition, and that in a good many instances it is both right and desirable for such endings to occur. Of course, there are instances in which a final preposition would be ugly and harsh, but there is no unbreakable rule about the matter. The writer who finds his sentence ending naturally and comfortably in a preposition should not suffer a sudden panic, and tie his sentence into knots in an endeavour to alter it. The probability is that, as originally written, it is better.

As an example of the entirely correct and euphonious employment of a final preposition, one may quote:—"I do not know what the world is coming to." Tricked out in accordance with the views of pedants, this might read: "I do not know to what the world is coming." There is no question which is the pleasanter phrase.

Similar rules for which there is no real justification are:—Do not end a sentence with "it"; do not begin a sentence with "but" or "and"; avoid using Latin words where Anglo-Saxon words (*i.e.*, with Anglo-Saxon roots) exist. It is such rules as this last that lead to the use of the word "save" for "except" by people who believe that "save" is Anglo-Saxon, though it is actually as Latin in its origin as the word for which it is substituted. The common instruction to avoid long words if short ones can be used is sound enough as a working principle, but even this becomes useless as soon as euphony and style come into one's calculations. There are innumerable instances in the writing of prose where the longer word, assuming it means the same thing, *has* to be used in preference to the shorter, because the extra syllables impart rhythms essential to the sentence as a whole. The imperfectly-trained reader never realises this, and it explains his frequent protests against the use of a longer word than he is accustomed to. Fine prose is as rhythmical as poetry or music, and those who write it have to satisfy ear as well as eye. But these are fine points that need not here detain the reader.

In most commercial houses, letter-writing is done by a process of oral dictation. It is but seldom that letters are actually written out in full by hand, except as drafts prior to dictation, where special care has to be exercised. The art of dictating efficiently differs in few respects from the art of letter-writing. The essence of the matter is to have all your facts, figures or details at hand before beginning, to know exactly what you want to say, to visualise the state of mind you wish to induce in the person to whom you are writing, and to be logical, consecutive, clear and concise. It is bad practice to ring for a typist, and then start rummaging for wanted papers in between jerked-out sentences. Such a practice produces the type of letter exactly corresponding to the dictation; a short, scrappy, inconsecutive letter that misses its mark or its points, and has to be rewritten hastily by harassed girls as their last task before departing.

In dictating, state first the name of the firm to whom one is writing, so that the typist can copy it into her note-book. The object of this is to have some clue to the letter should the correspondence file go astray and it becomes necessary to turn up the shorthand notes. Quote next the form of address (*i.e.*, "Dear Sir," "Gentlemen," and so forth), and follow up this with the reference heading, if any. Then proceed with the bulk of the letter, pronouncing clearly and dictating at a pace just slow enough to give the typist a second or so in which to amplify an outline or make a note, and just fast enough to keep her never more than a second or two in front. To keep a girl at top pressure the whole time is to run the risk of mistakes, and should be avoided if possible. (Many business men dictate at great speed, under the impression that this is a mark of efficiency, or because they think it good for the typist.) Clear pronunciation, with the spelling aloud of any unusual or difficult words, is most important. While with a good typist it is not necessary to mention every punctuation mark, it is always advisable to indicate fresh paragraphs, brackets, dashes and the less common stops, such as colons and semi-colons, by word of mouth, especially if the writer is fastidious on these points. This matter of clear dictation is stressed, having in the past suffered agonies in an attempt to record accurately the words of men who chewed large pipes while dictating, or nibbled their finger-nails, or spoke into their shirt-sleeves.

Näfveqvarn and the Swedish Exhibition.

The Swedish iron industry has very ancient traditions, and even to-day there hovers around the Swedish ironfoundries an air of legend and mystery which is in no small part due to the romance of the "Gösta Berlings Saga" by Selma Lagerlöf. During the many long wars of Sweden the skill of the ironfounder was exercised in the production of guns, often richly decorated with artistic ornament, and when the warriors returned to their homes in the country, they often adorned their gardens with urns of cast iron such as can be seen to this day.

With the technical progress of the nineteenth century the uses of cast iron developed to an incredible extent, and with it a decline of artistic merit. When the reaction against this industrial activity set in, the art foundry had practically disappeared. Then an old foundry, which had produced guns for Gustaf Adolf II, revived the manufacture of art castings, but, of course, in an entirely different manner from that of the nineteenth century. The Näfveqvarn works in the district of Kolmarden has resuscitated the Swedish tradition of ornamenting gardens with cast-iron urns. At first old urns were copied, but, through the instrumentality of the Swedish Arts and Crafts Association, co-operation was established with some of the younger sculptors and architects.

The result has been exceedingly successful. Outstanding in this connection is the sculptor Ivar Johnsson, who has created a series of garden urns revealing a happy combination of tradition and artistic individuality, and with a strong sense of the possibilities of expression. The sense for material appears particularly if one compares his cast-iron urns with the bronze urns which he has also designed for the Näfveqvarn works. The heavy, restrained modelling of the former is transformed into a graceful and elegant play of line and more developed plastic ornamentation.

Besides Ivar Johnsson, the sculptor Eric Grate has also executed compositions for this works. Most famous is the so-called "Bergslags urn," which deservedly attracted attention at the Paris Exhibition, 1925. His style in this urn has an antique style, harmonising well with the material.

Many other objects than these urns are produced at Näfveqvarn, such as railings, fireguards and the like, and the artists have been numerous, including Folke Bensow, Sven Häggborn and Harald Wadsjö. Cast iron has become popular in Sweden again, and the honour thereof is due to the Näfveqvarn works and to the artists who have striven for its success. Its products are to be shown at the forthcoming Swedish Exhibition of Industrial Arts and Crafts, which is to be held at Dorland House, 14, Lower Regent Street, from March 17 to April 22. It is interesting to note that principals of schools can obtain tickets for parties of scholars at half-price.

Dr. P. Bardenheuer to Address Tyneside Foundrymen this Month.

Dr. P. Bardenheuer, the well-known German foundry expert, of the Kaiser-Wilhelm Institut für Eisenforschung, Düsseldorf, is to address members of the Newcastle Branch of the Institute of British Foundrymen on Saturday, March 28, when he will deliver a Paper on the subject of "The Brackelsberg Process for the Production of Grey Cast Iron." The meeting will be held in the Neville Hall at 6.15 p.m., and a cordial invitation is extended to all foundrymen and members of kindred societies to attend.

Sand Tests in the Foundry.*

By J. Hird (Dursley).

In these days of cut prices and economical working, money is not spent unless a definite saving can be secured. This appears to be the reason why sand testing in the foundries in this country has not progressed. Foundrymen, specially of the old school, are very sceptical as to any real advantage to be gained by sand testing. When this subject is discussed, the first question asked is "Will there be any reduction in waste by having such tests?" The answer is very much in the affirmative.

It is the object of this Paper to bring forward the practical advantages of these sand tests and to illustrate the methods of conducting them.

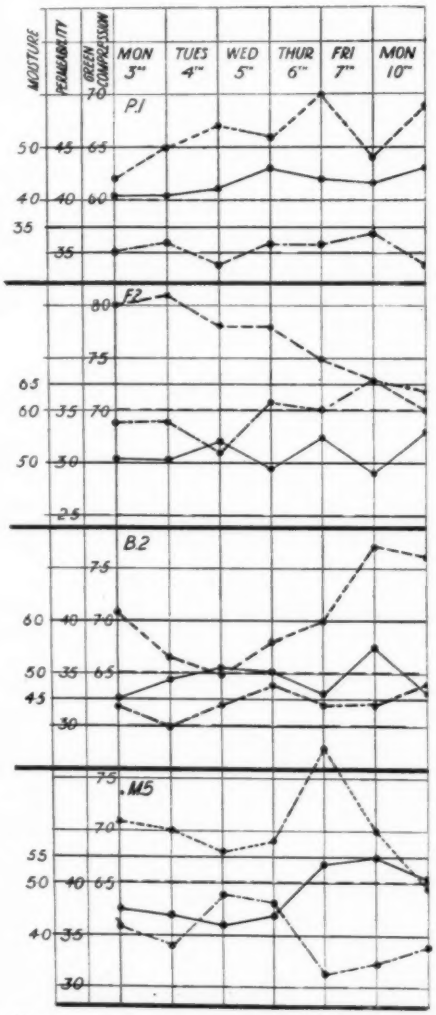

Fig. 1.—Daily Green-Sand Control Chart.

The full lines represent moisture, the dotted lines compression and the chain-dotted lines permeability.

There is nothing final claimed for these methods. Local conditions are the governing factors in making such tests; nevertheless, the general outline seems applicable to most foundries.

Necessary Apparatus.

The apparatus used is that which is recommended by the American Foundrymen's Association, as this was the only standard apparatus on the market when the tests were started. There are three tests necessary to give intelligible results, viz., moisture, permeability and strength. One is useless without the other two. These will give sufficient information to control the sand mixings used in the foundry. Sieve and sedimentation tests give valuable and interesting information, but are not essential.

Routine Tests.

The tests are taken on a routine basis and are a morning's work for an intelligent labourer. The charts, Figs. 1 and 2, have been drawn up to give a maximum meaning to the figures obtained in the tests. Fig. 1 is for green sand and facing sands, and Fig. 2 for dry sand, facing sands and core sands. In Fig. 1 the full lines represent moisture; in Figs. 1 and 2 the dotted lines represent green compression, whilst the chain-dotted lines represent permeability. In Fig. 2 the full lines represent dry shear. The straight-horizontal lines represent the lowest limits at which the sand is used. Below these limits the sand is returned to the mixer as unsuitable. There is also a maximum line for moisture.

Table I.—*Sand Mixings for "Simpson" Miller.*

Flycheel facing sand.—Mixture F. 2.
30 galls. red sand.
35 „ black sand.
5 „ coal dust.
Mix 15 min.; moisture 6 per cent. Mixings for machine Nos. 5, 6, 11 and 12.

Moulding-machine facing sand.—Mixture B. 3.
20 galls. red sand.
40 „ black sand.
5 „ coal dust.
Mix 15 min.; moisture 5.5 per cent. Mixings for machines Nos. 1, 2, 4, 9 and 10.

Plate- and jobbing-moulders' facing sand.—Mixture M. 5.
20 galls. red sand.
40 „ black sand.
5 „ coal dust.
5 „ mineral blacking.
Mix 15 min.; moisture 5 per cent.

Dry-sand facing sand.—Mixture D. 6.
10 galls. red sand.
45 „ black sand.
1½ „ core oil.
Mix 15 min.; moisture 7 per cent. Mixings for machines Nos. 7 and 8.

Core sand for large cores.—Mixture B.C. 7.
60 galls. black sand.
3 „ core oil.
Mix 15 min.; moisture 7 per cent. Mixings for corebench centre heap.

Table II.—"*Rotoil*" *Sand Mixings.*

Piston facing sand.—Mixture P. 1.
16 galls. black sand.
4 „ red sand.
2 „ coal dust.
Mix 10 min.; moisture 5 per cent. Mixings for machine No. 3.

Core-sand mixings for jackets, barrels, etc.—Mixture B.S. 8.
14 galls. sea-sand.
4 „ red sand.
1 gallon liquid core oil.
Mix 10 min.

Core-sand mixings for valves, etc., and facing large cores.—Mixture S.S. 9.
14 galls. sea-sand.
4 „ red sand.
1 gallon semi-solid core oil.
Mix 10 min.

Sand Mixings.

The sand mixings, referred to in Figs. 1 and 2, are given in Tables I and II.

P. 1 is a piston facing sand. This sand is made to prevent scabbing on the bottom face of the piston. The sand is kept dry, as no great strength is needed.

F. 2 is a flywheel facing sand, which is particularly strong, as the method of pouring the wheels fills the mould rather slowly and the top has a tendency to drop or draw down. As this sand is liable to scab if used in the bottom half of the mould, an ordinary facing sand, B 3, is used.

B. 3 is a facing sand for machine moulding; it is used on machines of the jolt-ram type making crankcases, pulleys and similar castings up to 2½ cwts. in weight.

M. 5 is a plate-moulders' facing sand, also for jobbing work. The mineral blacking is added to improve the skin of the casting, as plate moulders do not always shake blacking over their moulds, and when they do, 90 per cent. is usually blown off.

D. 6 is used as a cylinder facing sand for dry-sand work. High strength is obtained when dry by the high moisture content when green, and the use of core oil in the mixing. The iron pattern is sprayed with paraffin to prevent clagging.

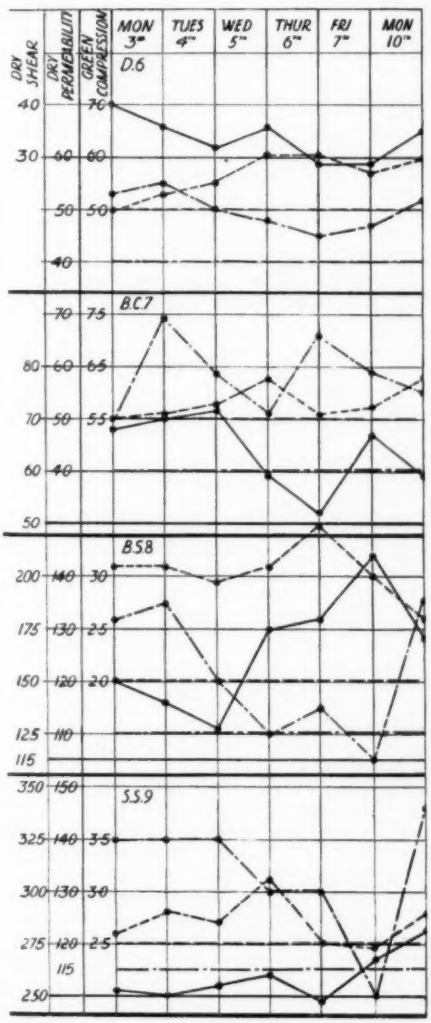

Fig. 2.—Daily Chart for Dry Sand, Facing Sand and Core Sand.

The full lines represent dry shear, the dotted lines green compression and the chain-dotted lines permeability.

B.C. 7 is a core sand used on large body cores and feet cores for crankcases, that is for cores weighing ½ to 1½ cwts. Core sand B.S. 8 is used to face some of these cores where there is a wash of metal.

B.S. 8 is a sea-sand core sand, but red sand is added to give green-bond strength and so dispense with shell carriers. The red sand is kept to a minimum to obtain a high permeability. This sand is used in cylinder barrels and jacket cores.

D

* A Paper read before the Wales, Monmouth and West of England Branch of the Institute of British Foundrymen, at a meeting held at the Technical College, Newport.

S.S. 9 is a strong sea-sand core sand used for valves, small round cores and any high-duty cores where good permeability and strength are necessary.

Method of Mixing Sand.

Two mixers are used, a "Simpson" and a "Rotoil." The "Simpson Mixer" is run for the unusual time of 15 minutes per mixing. It has been found that extended milling gives maximum strength without decreasing the permeability of the sand in this type of mixer. Table III shows the results of some experiments

Table III.—*Effect of Extended Millings on Sand Mixings.*

Time. Min.	Permeability.	Green compression.	Moisture.
2	21	5.7	6.8
4	19	6.6	6.8
6	19	7.5	6.6
8	21	7.5	6.6
10	20	8.0	6.6
12	22	8.2	6.5
8	25	5.2	6.2
10	25	6.2	6.2
12	25	7.0	6.3
14	25	7.4	6.2
16	25	7.4	6.2
12	19	6.9	6.3
14	20	7.5	6.4
16	20	7.6	6.3
18	20	7.7	6.4
8	26	5.0	5.0
10	27	5.8	5.2
12	28	6.2	5.2
14	28	7.0	5.2
7	22	6.2	4.9
15	21	7.0	4.9
30	20	7.2	5.0
7	24	6.5	5.2
15	27	6.3	5.4
7	21	6.6	6.0
15	27	7.6	6.0
7	23	7.8	5.0
15	26	8.5	5.1
30	27	8.7	5.2
7	25	7.0	4.6
15	29	8.0	4.8
30	30	8.1	4.7

that support this conclusion. Up to 15 minutes' milling there is a steady increase in strength without any decrease in permeability, yet beyond this period there appears to be little change up to 30 minutes.

The consistency of the permeability figure seems to prove that there is no crushing of the sand grains. The saving in red sand and the gain in strength are worth the cost of 15 minutes' milling. A mixing consists of 60 gallons of sand or approximately 8 cwts. This gives ample sand under the mullers and probably accounts for the consistency of permeability over extended milling. The advantages of extended milling are:—(1) Saving in red sand, (2) maximum strength of sand obtained and (3) absolute uniform distribution of the bond. This is essential in obtaining an ideal sand.

Coal Dust.

It has been found that additions of coal dust or mineral blacking, as in Sand M. 5, actually increase the strength of the sand with very little loss of permeability. This is only the case when the sand is milled for 15 minutes. When coal dust is added after milling and the sand put through a half-inch riddle, the usual effects are noticed, *i.e.*, a decrease in strength and a more noticeable decrease in permeability. (See Table IV.) Possibly the increase in strength when coal dust is added before milling can be accounted for by the very fine coal dust being absorbed in the bond by the extended milling and so becoming virtually part of the bond. When the sand is insufficiently milled, this cannot take place and the coal dust fills the pore spaces formed by the grains of sand, thus lowering the permeability.

Oil-Sand Mixing.

The "Rotoil Mixer" is specially designed for mixing oil sand. Two gallons of thoroughly dried cold sea-sand are first put into the mixer, followed by a gallon of core oil, and then the

Table IV.—*Effect of Extended Millings on Coal Dust in Sand Mixings.*

Sand.	Time. Min.	Permeability.	Green compression.	Moisture.
B.3 60-gallon mixing milled without coal dust	15	33	6.8	5.8
Put through ¼-in. riddle	—	35	6.8	5.8
5 gallons of coal dust added and again riddled	—	27	6.3	5.0
Put through ¼-in. riddle again ..	—	26	6.5	4.9
Milled for	7	30	7.8	5.0
F.2 60-gallon mixing milled without coal dust	15	27	7.9	6.0
Put through ¼-in. riddle	—	30	6.9	5.9
5 gallons of coal dust added and again riddled	—	22	6.5	5.3
Put through ¼-in. riddle	—	25	6.4	5.3
Milled for	7	28	8.0	5.2

remainder of the sea-sand. This is allowed to mix for 5 minutes, when the red sand is added. Then the whole is mixed for a further 5 minutes, a total of 10 minutes. The timing is done accurately on both machines with special alarm clocks, which are set to give the alarm at the required times. The apparatus is similar to that used in billiard halls, and is supplied by makers of billiard accessories.

Core-Stove Practice.

The correct drying of cores is just as important as the proper mixing of the core sand. It also follows that to obtain correct drying control is necessary. It is well known that the proper way to dry oil-sand cores is in a stove, separate from any moulds or naturally-bonded cores, which create steam. The reason for this is that the moist, humid atmosphere, prevailing in a stove containing steam, tries to reach equilibrium (*i.e.*, any parts containing no steam, such as oil-sand cores). This absorption during the drying greatly affects the strength of the oil-sand cores. Oil-sand cores can be dried with some measure of success in a stove with naturally-bonded sand. However, the success depends upon the ratio between the two and the less naturally-bonded sand, the better for the oil sand.

Oxidising Atmosphere.

Heat with either a reducing or oxidising atmosphere will dry naturally-bonded sands, but for the correct drying of oil sands an oxidising atmosphere is necessary. There is an oxidising atmosphere in almost every core stove, but an atmosphere conducive to best drying for oil-sand cores must be really oxidising, *i.e.*, have a good supply of *hot unburnt air* passing into the stove. The application of forced draft is ideal for this purpose. The well-known "Acme" system is used. By this method a large volume of heated secondary air is injected into the stoves, under slight pressure (in addition to the air taken directly through the fire), thus providing the necessary additional oxygen. The pressure factor has a penetrating effect on the cores and dries them much quicker than is possible with natural draft.

Pyrometer Control.

All stoves should be fitted with some form of pyrometer control. Forced-draft stoves fitted with thermometers should have a 1½-in. dia. hole arranged so that a stream of hot air from the stove passes over the bulb of the thermometer out into the atmosphere. This gives a true reading of the temperature in the stove whilst the blower is on. When the blower is stopped and the stoves are allowed to stand, before the doors are opened, the 1½-in. dia. hole should be closed to stop the cold air from passing over the bulb of the thermometer into the stove. Then a true reading of the temperature in the stove is again obtained.

Check on Control.

A check on the working of thermometers or other stove control is obtained in a simple and effective way. Low-temperature "Sentinel" pyrometers are used in cast-iron containers about 4½ in. long by 1½ in. high and 1¼ in. wide having three compartments 1¼ in. square in which the cores are placed. Useful temperatures are 220 deg. C., 230 deg. C., 240 deg. C. When the 220 deg. C. cone has melted, the 230 deg. C. should just be starting and the 240 deg. C. cone unchanged. A check on the distribution of the heat in the stove is made by placing several of these sets of cones in different positions in the stoves.

Chart for Core Stoves.

A chart which is hung on each core-stove door is shown in Fig. 3, a new chart being used

Stove No. 5. Date 9.12.30. Cores used cast No. C.92.

Operation.	Time.	Temperature.	Heat units.
Stove fired	5 p.m.		
Temperature up ..	5.40		
Temperature ..		400° F.	
Heat units	40 min.		140
1st half hour ..	6.0	400°	130
2nd " " ..	6.30	380°	190
3rd " " ..	7.0	400°	200
4th " " ..	7.30	390°	195
5th " " ..	8.0	400°	200
6th " " ..	8.30	400°	200
7th " " ..	8.40	400°	67
8th " " ..			
9th " " ..			
10th " " ..			
Heat units	3 hrs.	396° average	1,182
Doors opened ..	6.0 a.m.	130°	
Heat units	9 hrs. 20 min.	265° average night temp.	2,472
Total heat units ..	13 hrs.		3,794

Permeability of test core .. 125
Dry shear of test core .. 120
Remarks.—220° C. melted. 230° C. and 240° C. not melted. Cores correct.

Fig. 3. Core Stoves Temperature Chart.

daily. The operator fills in the details every half-hour. The "heat units" refer to the figure obtained by multiplying the temperature by the hours at that temperature. This calculation is filled in at the office. The heat-unit figure is obtained for easy comparison. Cores baked at 450 deg. F. for 1 hr. (450 H.U.) are practically equivalent to cores baked at 360 deg. Fah. for 1½ hrs. (450 H.U.). Of course, this argument has limits. It holds good, however, within the range of temperatures at which the bond burns away on the outside of the core before the centre is dry. The heat-unit figure is useful as a comparison of variations in the baking of the cores and is a convenient number to graph. The graphing of these figures for five stoves will be seen in the bottom space, Fig. 4.

Test cores are placed in each stove, one core for dry shear and a tube for dry permeability. The results of these tests are filled in on the chart (Fig. 3). The "Remarks" state which of the "Sentinel" pyrometers has melted, and the reason, if any, for abnormal variations in the temperature of the stove. One half of the broken dry-shear test core out of each stove is preserved and the series for each day placed one

on top of the other. These are put on a shelf by the side of the previous day's cores. By comparing the variation in colour of these cores, a useful check on the working of the stoves is obtained. The test cores for the stoves are all made from standard sand mixings. A key sample is dried for 1 hr. at 400 deg. Fah. in a "Model Stove." This stove is under ideal control and is used for drying samples of each core sand every day. Thus the quality of the sand being used is known before many cores have been made. Doubtful sand can be condemned and the cores made from it destroyed. This rarely occurs, but the test ensures that no "dud" sand is used.

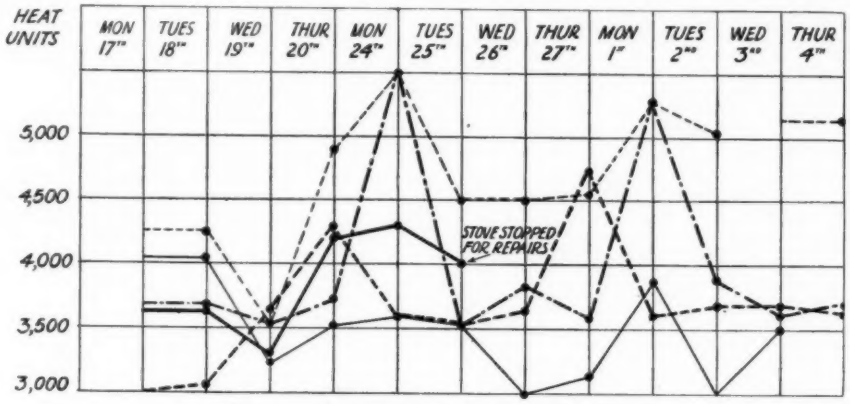

FIG. 4.—HEAT UNITS USED FOR CORE-DRYING.

No. 1 stove, thick full lines; No. 2, thin full lines; No. 3, thick dotted lines; No. 4, thin dotted lines; and No. 5, chain-dotted lines.

Grading Cores.

All cores should be graded for drying, the large cores in any stove being at the top near the inlet flues. When forced draft is used there is a pressure inside the stoves of about two atmospheres. The difference in the temperature in various parts of the stoves is not so marked, though the grading is quite important.

Grain Size of Sand.

Grain size has the same relation to permeability as bond has to strength. Both permeability and strength are dependent on moisture. Sand grains of uniform size (round, rather than angular in shape) give highest permeability. A good grain size sand should leave 75 per cent. of its grains on 60- and 90-mesh sieves, and not more than 10 per cent. pass 150-mesh.

When sand grains are heated to casting temperature, especially if they contain moisture, they break up into smaller grains and so lower the permeability of the sand. Some sands are more liable to this breaking-up than others. The extent to which sand breaks up on heating should be ascertained when buying new sand, as this plays a very important part in the maintaining of a high and even permeability. The sintering is done by placing sand in a heavy tin container in a mould and casting about 2 in. of iron around the tin and leaving until cold.

Dust Extraction.

A machine is used to extract these finely-broken sand grains or dust from the sand. The machine consists of a bucket elevator discharging over a rotary magnet. The sand falls from the magnet on to a long narrow riddle. The riddle shakes over a chamber, along the bottom and one side of which are rows of small compressed air jets. This keeps the fines in suspension while it is extracted from the chamber by a suction fan along the opposite side to the air jets. The larger sand grains fall through a narrow opening in the bottom of the chamber. Only dry sand is used, and between 2 and 3 per cent. of fines is extracted. This makes it possible to salvage sand which is usually thrown away through being considered burnt and too fine for use and to maintain a high permeability in the sands in use. The fines consist of (1) burnt coal dust or fine coke; (2) burnt blacking and plumbago, and (3) very fine sand grains.

Measuring Grain Size.

Grain size, though as important as bond, is much more difficult to ascertain and control, being usually considered a laboratory job and also a tedious one. It is possible, however, to arrive at quite accurate results by measuring the volume of the sand remaining on the sieves. The method is to take 100 c.c. of the sand to be tested and pass it through the sieves (a nest of 30-, 60-, 90- and 150-mesh sieves is very useful), perfectly dry sand being used if there is little or no bond in it. Bonded sands are dealt with later.

When shaking by hand, it is best to time the agitation. It is difficult to fix a standard time of agitation for each size of sieve, as much depends on the amount of sand remaining on the sieves. When comparing two similar sands, the time of agitation can be taken. A good method is to remove the topmost sieve and shake it over a piece of clean paper. If practically no sand falls on the paper, that sieve can be set on one side and the next proceeded with. Usually the shaking of a set of sieves takes from 8 to 10 min. The sand remaining on the sieves is now measured, and as 100 c.c. was originally on the sieves these figures can be expressed as percentages. In measuring the sand the measure glass should be given three sharp raps on a solid table. This settles all the sands evenly and minimises error in that direction. Accuracy of 99 per cent. is easily obtained with this volumetric method.

Conversion to gravimetric figures can be obtained by finding the weight of 1 c.c. of sand of each grain size. Although this varies a little for different sands, it has been found to be in the region of:—

1 c.c. of sand remaining on 60-mesh sieve, 1.12 grams.
1 c.c. of sand remaining on 90-mesh sieve, 1.13 grams.
1 c.c. of sand remaining on 150-mesh sieve, 1.14 grams.
1 c.c. of sand passing 150-mesh sieve, 1.28 grams.

For internal comparative purposes this conversion is not necessary. If it is intended to convert the figures it is best to take 100 grams of sample in place of 100 c.c.

Grain Size of Bonded Sands.

This is rather a longer process. However, as it is not usually necessary to take the grain size of many bonded sands, this drawback is minimised. The test takes about 40 minutes. The extra apparatus needed for the bonded sand is a deep bottom part to fit under the smallest sieve in place of the shallow one used when testing unbonded sands. This deep part should be about 12 in. deep with 6-in. dia. sieves and fitted with a draw-off tap about the middle. A water gauge the full depth of the container is also necessary.

A 100 c.c. of the sand to be tested is measured in water. That is, the measure is half-filled with water and the sample carefully dropped in until the sand reaches the 100-c.c. mark. The sand is then poured on to the top sieve of the nest and the measure washed out. The sand (or as much of it as will) is now washed through the top sieve with the aid of a small stream of water and a camel-hair brush. Note is taken of the height of the water in the bottom container (indicated by the water gauge). When the container is nearly full, washing is stopped and the water in the container is allowed to settle for a minute.

The water is now drained off to the level of the draw-off tap. Washing is continued until the

(*Concluded on page* 197.)

TABLE V.—*Sand Data Sheet.*

Sand. Figures in black refer to sand after sintering. Italics refer to sand before milling.	Date	Sieve tests. Stay on 30 mesh.		Stay on 60 mesh.		Stay on 90 mesh.		Stay on 150 mesh.		Pass 150 mesh.		Sedimentation. Bond. By dif.	Act.	Silt.		Medium sand.		Coarse sand.		Permeability, strength. Green 5% moist.		Dry 1 hr. 350° F.		Comp'n. 5% moist.		Shear 1 hr. 350° F.		Moisture.
Stourbridge red sand in use	8–11	0.25	*0.5*	8	*20*	35	*50*	10	*9*	9	*9*	38	40	—	—	50	*80*	10	—	*61*	46	*74*	60	*3.9*	6.3	*16*	17	7.0
Sample of red sand from Stourbridge District	18–11	0.5	—	7	—	23	—	17	—	15	—	37.5	40	5	—	55	—	—	—	*38*	23	*45*	30	*3.0*	5.4	*13.5*	18	7.3
Sea-sand in use	25–11	0.2	**0.3**	21	**9**	63	**73**	12	**10**	6	**6**	—	—	2	**4**	98	**96**	—	—	105	—	—	—	—	—	—	—	—
Sample of dune-sand from Glamorganshire	3–12	0.4	**0.4**	11	**8**	73	**75**	9.5	**11**	7	**5**	—	—	3	**3**	97	**97**	—	—	105	—	—	—	—	—	—	—	—
Burnt sea-sand core sand from knockout	4–12	0.5	—	10	—	62	—	20	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Above sand put through dust extractor	4–12	0.5	—	10	—	64	—	20	—	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unused cores milled in Simpson for 1 hr., dry	6–12	0.3	—	15	—	54	—	15	—	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sample of red sand from Mansfield district	12–12	1.1	—	2.2	—	2.4	—	8.3	—	40	—	46	50	—	—	—	—	—	—	—	—	—	20	—	—	—	48	7.5

Permeability of Grey Cast Iron to Gas at High Pressures.

After a brief summary of the literature dealing with the permeability of iron and steel to various gases, B. Beer has described the method he used and presented data on the permeability of some cast irons.* In order to avoid the effect of the intercrystalline cavities through which, as experiments with steel have shown, only hydrogen in the atomic state can pass, in the present experiments carbon dioxide, which is about 22 times as dense as hydrogen, was used as pressure gas.

The test samples were cylinders (A, Fig. 1) closed at one end which, with the aid of an

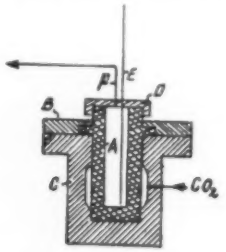

Fig. 1.—Permeability Testing Apparatus.

annular cover B, were firmly screwed to a pressure vessel C. The carbon dioxide was taken from a steel cylinder and introduced into the interior of the pressure vessel, wherefrom it could penetrate through the wall of the test cylinder into the annular cavity shown. The open end of the test cylinder was firmly closed by a cover D furnished with two copper tubes. Tube E served for washing the carbon dioxide out of the cylinder, tube F connected the interior of the cylinder with the measuring apparatus.

Two methods were used for measuring the volume of CO_2 penetrated into the test cylinder. In the first method several graduated glass cylinders, standing bottom upwards in a glass trough filled with water, were connected with the copper tube F. Under special precautions the CO_2 and the air displaced by it from the interior of the test cylinder were caught up in the glass cylinders, and from the increase in volume, making allowance for the temperature and the pressure of the gas, the volume of penetrated CO_2 was calculated at 20 deg. C. and 760 mm. of mercury. This method is suitable for measuring large volumes of gas—that is, with highly permeable or defective material, because any number of measuring cylinders can be used. The accuracy of measurement was stated by blank experiments to be ± 0.01 cm.³ per minute. In the second method the CO_2 was washed out of the test cylinder, with the aid of the copper tube E, by a current of dry air, free from CO_2, and pressed through two measuring vessels filled with caustic potash (KOH) and through a U-tube filled with calcium chloride ($CaCl_2$). The volume of the CO_2 was calculated from the increase in weight of the two vessels and the U-tube ($2KOH + CO_2 = K_2CO_3 + H_2O$). The washing process was continued for five hours. The accuracy of measurement was ± 0.001 cm.³ per minute. With the second method the test can be continued for a long period of time, and, therefore, this method is suitable for testing dense materials through which only a small volume of gas can pass.

Eight kinds of cast iron were tested, using gas pressures from 15 to 45 atmospheres. In Table I the permeabilities found with a CO_2-pressure of 45 ats. and with various wall-thicknesses are recorded, the test samples being arranged according to their densities. About the same order results when the samples are arranged with respect to the size and distribution of graphite. The experimental results can be summarised as follow:—(1) The volume of gas penetrated through the wall of the test cylinders proportionally increased with the increasing time of loading; the volume of gas absorbed by the wall proportionately increased with the time during the first hours of the experiments, reached a maximum value, and then remained constant. (2) After unloading, the release of the gas absorbed by the material continued for a very long time; a test cylinder with a wall-thickness of 12 mm., for instance, still released 1.14 cm.³ of gas per 24 hours after 11 days. (3) The better the surface of the test cylinder had been machined the lower was the permeability. (4) The permeability increased with the increasing gas pressure when the wall-thickness was kept constant, and with the decreasing wall-thickness when the pressure was kept constant. (5) The volume of gas released by the wall after unloading was approximately proportional to the permeability, and showed a maximum value with a definite wall-thickness of each material. (6) Shortly after loading a great increase in volume was observed, shortly after unloading a decrease in volume; the change in volume was accompanied by a change in temperature of the test cylinder.

Table I.

Wall-thickness, mm.	12	11—10	8	6	4	3
Sample.	Permeability cm.³ per minute.					
E_1	0.0007	0.003	0.010	0.012	0.024	0.041
K_4	0.002	0.010	0.020	0.039	0.063	0.078
K_3	0.003	0.011	0.021	0.032	0.065	0.105
L_3	0.008	0.017	0.028	—	—	0.043*
E_2	0.046	0.060	0.089	0.102	0.141	0.178
L_4	0.097	0.107*	0.103*	0.136*	3.79*	24.77*
L_1	2.991	1.392*	0.415*	0.744*	0.078*	0.037*
L_2	5.648	6.167*	5.327*	3.896*	2.663*	0.744*

* Testing conditions changed.

Sample.	Chemical composition.			
	T.C.	C.C.	Gr.	P.
E_1	3.06	0.88	2.18	0.988
E_2	3.05	0.56	2.49	0.954
L_1	3.36	0.85	2.51	0.226
L_2	3.28	1.02	2.26	1.174

The mechanism of permeability is explained as follows:—After loading, the pressure gas first enters the pores and cavities, which are connected with the surface of the sample, and when the pressure is maintained penetrates into the interior along the graphite flakes. The more permeable the iron is the further will the pressure be carried into the interior, and the curves representing the difference of the pressures prevailing in the interior of the wall and at the inner surface of the test cylinder become more and more vertical (see Curves 2 and 3, Fig. 2); that is, the volume of gas which passes through the wall increases. With a dense material, on the other hand, the pressure penetrates into the interior only to a short distance from the surface, and, in this case, the pressure-difference curve takes a more inclined course (Curve 1, Fig. 2); that is, the gas volume which can pass through the cylinder wall is only small. By the penetrating gas the iron is destroyed, especially the graphite flakes. The more the material is destroyed the larger is the volume of gas which can be absorbed (or released after unloading), and the maximum volume is reached when the material is destroyed throughout. When the test-cylinder is turned to a thinner

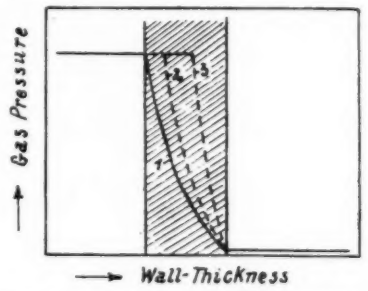

Fig. 2.—Mechanism of Permeability.

wall-thickness part of the destroyed material is removed, the gas, on the other hand, can now penetrate further into the interior and destroy more material hitherto unattacked. Therefore, the volume of gas absorbed will increase with the decreasing wall-thickness until the whole material is destroyed, then it will decrease. As the speed with which the iron is destroyed depends upon the permeability, the maximum value will be found with a definite wall-thickness of each material. The increase in temperature which was observed shortly after loading is attributed to plastic deformations in the material. These deformations loosen the graphite flakes, thus aiding the pressure gas in destroying the metal. The loosened graphite, however, is pressed by the gas towards areas of lower pressure, whereby the density of the sample is increased. When the test-cylinder is turned to a thinner wall-thickness the pressure drop in the wall is intensified; that is, its effect upon both the destruction and the displacement of the graphite is increased. The permeability depends upon the ratio of the degree of destruction to that of displacement. When the destruction is greater the permeability increases with the decreasing wall-thickness (samples E_1, K_4, K_3, L_3, E_2, L_4, Table I); however, when the degree of displacement is higher the permeability decreases with the decreasing wall-thickness (samples L_1 and L_2).

* "Die Giesserei," 1930, Nos. 17 to 19.

A Rival of the International Railmakers' Association.—The Irma, to which belong Great Britain, with a quota of 24.75 per cent.; Germany, with 19.575 per cent.; the United States, with 18.5 per cent.; France, with 17.6 per cent. the Socobelge, with 5.485 per cent.; other Belgian works, with 8.84 per cent.; Luxemburg, with 4.95 per cent.; and the Mid-European group (Czecho-Slovakia, Austria and Hungary), with 4 per cent., is now menaced by competition from Japan. The Yawata Steelworks are making strenuous efforts to get a footing in foreign markets. In Egypt and South Africa offers have already been received from rail makers in Japan at generally tempting prices, so that the Irma will have to regard this newcomer.

Some New Views on Smelting and Remelting Processes.

By J. E. Fletcher, M.I.Mech.E.

(*Continued from page* 176.)

Summary of the Alloying Reactions.

Eutectic (4.3 per cent. C) required for Si = 26.9 lbs.
" " " " Mn = 4.6 lbs.
" " " " P = 12.8 lbs.
Total 44.3 lbs.
= 42.4 lbs. Fe + 1.9 lbs. C.

The composition of the alloyed constituent is:—

Fe	42.40 lbs.	94.02	per cent.
Si	1.35 lbs.	3.00	"
Mn	0.75 lb.	1.67	"
P	0.57 lb.	1.27	"
S	0.02 lb.	0.04	"
	45.09 lbs.	100.00	"

In this final estimate the sulphur is taken as being divided between the alloyed portion and the remainder of the eutectic after alloying, whose weight is 98.24 – 45.09 = 53.15 lbs.

The analysis of the alloyed constituent may now be written as under:—

Fe_2Si	=	6.75 lbs.
Mn_3C	=	0.77 lb.
MnS	=	0.05 lb.
Fe_3P	=	3.66 lbs.
Free Fe	=	33.86 lbs.
		45.09 lbs.

The free iron, Fe, in the alloyed constituent, if recarburised from the coke carbon in the furnace hearth to form the eutectic (4.3 per cent. C) will require 1.52 lbs. carbon.

The full analysis of the carburised alloyed constituent will then be as given below:—

Si	1.35 lbs.	2.90	per cent.
Mn	0.75 lb.	1.61	"
S	0.02 lb.	0.04	"
P	0.57 lb.	1.22	"
C	1.55 lbs.	3.33	"
Fe	42.40 lbs.	90.90	"
Total	46.64 lbs.	100.00	"

The original weight of carburised sponge iron taken to be of eutectic composition (4.3 per cent. C) was, per 100 lbs. of pig-iron, 98.24 lbs. Of this 98.24 lbs. the alloying reactions demanded 44.3 lbs., leaving 53.15 lbs. of unaltered eutectic, containing 2.28 lbs. carbon. The fully-eutectic pig-iron would therefore contain 2.28 + 1.55 = 3.83 lbs. of carbon, corresponding to 3.83 per cent. The pig-iron actually contained 3.1 per cent. of carbon. It is evident, therefore, that the alloyed constituent was not carburised to the fully-eutectic condition and only contained 0.82 lb. of carbon instead of 1.55 lbs. required for carburising to the eutectic condition.

The estimates show, as does the chemical analysis of the pig-iron, that the cold-blast pig-iron is hypo-eutectic. There are two possible explanations for the hypo-eutectic condition in cold-blast pig-irons: (1) The sponge iron may not be fully carburised to the eutectic condition whilst the alloyed portion may be, and (2) the sponge iron may be fully carburised to the eutectic condition and the alloyed portion may be only partially carburised, being hypo-eutectic. These two conditions will now be separately considered.

(1) *The formation of sponge iron in the reduction zone of the blast furnace followed by the carburisation of the sponge iron as it descends to the hearth as molten eutectic iron of* 4.3 *per cent. carbon content in irons of medium and high silicon content and as hypo-eutectic iron of less than* 4.3 *per cent. carbon content where the silicon content is low.*

The slower the rate of driving the lower is the hearth temperature. The weight of gases ascending through the burden column is less as the rate of driving is reduced and the mean temperature of the gases traversing the burden column is correspondingly lowered. A Swedish cold-blast furnace working on rich ores and using charcoal as fuel produced more iron per sq. ft. of hearth area per hour than an English cold-blast furnace using lean ores and coke. In the first case the sponge iron is carburised to the eutectic condition before reaching the tuyere zone, even when yielding low-silicon iron. The total-carbon content of a number of high-quality Swedish cold-blast pig-irons is given in Table I.

Table I.—*Composition of a Series of Swedish Cold-Blast Pig-Irons.*

Pig-iron.	Si.	Mn.	T.C.	Estimated T.C. in eutectic iron.
	Per cent.	Per cent.	Per cent.	Per cent.
No. 1 ..	1.16	0.79	3.96	4.04
No. 2 ..	1.15	0.06	3.70	3.99
No. 3 ..	1.19	1.55	3.53	4.08
No. 4 ..	1.02	0.98	3.92	4.07
No. 5 ..	0.81	1.33	4.20	4.20
No. 6 ..	1.17	0.50	4.24	4.04
No. 7 ..	0.58	2.30	4.02	4.23
Mean ..	1.01	1.07	3.94	4.09

The phosphorus content in all the above pig-irons was under 0.03 per cent. and the sulphur content was under 0.02 per cent. The total-carbon contents of eutectic irons as estimated by the author's two-constituent method are shown in the last column to the right. The mean values show that the irons are slightly hypo-eutectic, though actually No. 5 is truly eutectic and No. 6 hyper-eutectic. In practice, iron of brand No. 6 was " kishy " and showed graphite pockets in pigs occasionally. A comparison of the Swedish with English cold-blast pig-irons is given in Table II.

Table II.—*English Cold-Blast Pig-Irons.*

Pig-iron.	Si.	Mn.	P.	T.C.	Estimated T.C. in eutectic.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
No. 1 ..	1.60	0.90	0.60	3.12	3.77
No. 2 ..	1.35	0.75	0.57	3.10	3.83
No. 3 ..	1.16	0.70	0.54	3.11	3.89
No. 4 ..	1.00	0.65	0.50	3.15	3.93
No. 5 ..	0.90	0.57	0.50	3.16	3.96
No. 6 ..	0.60	0.42	0.40	2.90	4.05
No. 7 ..	0.56	0.47	0.42	3.00	4.06
No. 8 ..	0.47	0.22	0.52	2.73	4.07
Mean ..	0.95	0.58	0.50	3.04	3.95

Some very interesting and practical deductions can be made by studying the two cold-blast irons (Swedish and Staffordshire) in the light of the two-constituent theory.

The mean analysis of the seven Swedish irons is seen to be:—

Si.	Mn.	P.	S.	T.C.	Fe by difference.
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1.01	1.07	0.02	0.02	3.94	93.94 actual.
1.01	1.07	0.02	0.02	4.09	93.79 if eutectic (estimated).

The author's method before described, by which the composition of the two constituents can be estimated, is capable of showing the silicon content in irons of 1.07 per cent. Mn, 0.02 per cent. P and 0.02 per cent. S contents when the whole of the original carburised sponge iron of eutectic composition gives up its carbon in the alloying reactions. This critical Si content can be determined by means of the expression

$$\text{Si per cent.} = \frac{100 - (7.76\,\text{Mn} + 23.5\,\text{P} + \text{FeS})}{20.93}$$

In the above Swedish pig-iron the critical Si content is

$$\frac{100 - (8.3 + 0.47 + 0.05)}{20.93} = \frac{91.18}{20.93} = 4.59 \text{ per cent.}$$

This means that if the hearth temperature were sufficiently high a eutectic iron containing 4.59 per cent. Si would result. The composition of the iron would be, before the Fe liberated by the alloying reactions is re-carburised:—

Si	4.59 lbs.	or Fe_2Si	22.95 lbs.
Mn	1.07 lbs.	or Mn_3C	1.15 lbs.
S	0.02 lb.	or FeS	0.05 lb.
P	0.02 lb.	or Fe_3P	0.13 lb.
Fe	90.25 lbs.	or Fe (free)	72.79 lbs.
	95.95 lbs.		97.07 lbs.

The free Fe, 72.79 lbs., takes up 3.27 lbs. carbon when recarburised to the eutectic condition (4.3 per cent. C and 95.7 per cent. Fe content). The eutectic iron has then the composition, based on the Si being present as Fe_2Si (or FeSi + Fe), as deduced from Wüst and Peterson's researches: Si, 4.59; Mn, 1.07; S, 0.02; P, 0.02; C, 3.35 (3.27 + 0.08), and Fe, 90.95 per cent.

By the same method of calculation the weight of the alloyed constituent and its composition when recarburised to the eutectic condition is determined. The remainder of the metal consists of the unaltered primary eutectic (carburised sponge iron of 4.3 per cent. content). If the Mn, S and P contents remain constant, it will be found that the relative percentages of the two constituents for increasing Si contents vary as shown in Table III (over-leaf).

The composition of the alloyed constituents (recarburised to eutectic condition) is in Table IV.

From the foregoing estimate of the percentages of the unaltered eutectic constituent (carburised sponge iron) the total-carbon content in the pig-irons can be estimated. These fully-eutectic pig-irons would have the following total-carbon contents:—

For Si, per cent.	0.0	1.0	2.0	3.0	4.59
Total-carbon contents	4.3	4.1	3.9	3.67	3.35 per cent.

The high-silicon contents in the alloyed constituent when the Si percentage in the pig-iron reaches 1.0 per cent. and over is noticeable, as is the high Mn content in the alloyed constituent in pig-irons of less than 1 per cent. Si content. (See Table IV.) One cannot escape the light thrown upon the constitution of pig-irons used for malleable cast-iron manufacture by the two-constituent theory when studying the effect of the high Si and Mn contents of the alloyed constituents in cast irons of less than 1 per cent. Si content. The high proportion of the unaltered eutectic constituent (white iron free from Si and Mn, in which most of the sulphur must be present as the carbide stabiliser) suggests the reason for the long period of annealing necessary to graphitise this constituent. The increasing influence of Si in the alloyed constituent, which is equivalent to a grey iron of high Si content (above 3 per cent. in low Mn irons) suggests that this constituent is the dominating influence in graphitising the metal by long annealing.

English Cold-Blast Pig-Irons.

In the same way as in the foregoing case, the chemical analyses of the eight pig-irons can, by the two-constituent method, enable the relative percentages of the two constituents in the irons of varying Si content to be determined. These are given in Table V.

Table III.

	0.0 per cent. Si	1.0 per cent. Si	2.0 per cent. Si	3.0 per cent. Si	4.59 per cent. Si in pig-iron
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Alloyed constituent	8.8	29.8	50.3	71.1	100.0
Unaltered eutectic constituent	91.2	70.2	49.7	28.9	nil

Table IV.—*Composition of the Alloyed Constituents.*

For Si contents in pig-iron ..	Per cent. 0.0	Per cent. 1.0	Per cent. 2.0	Per cent. 3.0	Per cent. 4.59
Si	0.0	3.38	3.97	4.27	4.59
Mn	12.15	3.59	2.12	1.53	1.07
S	0.23	0.02	0.02	0.02	0.02
P	0.23	0.07	0.04	0.03	0.02
C	4.30	3.68	3.50	3.47	3.35

Table V.—*Relative Percentages of Alloyed and Unaltered Constituents in English Cold Blast.*

Nos.	1	2	3	4	5	6	7	8	Mean	Si free
Si	1.60	1.35	1.16	1.00	0.90	0.60	0.56	0.47	0.95	0.00
Alloyed constituent ..	54.15	47.00	45.00	38.30	32.00	24.85	25.00	23.55	35.90	16.10
Unaltered (eutectic + Fe) constituent	45.85	53.00	57.00	61.70	68.00	75.15	75.00	76.45	64.10	83.90

The unaltered eutectic (carburised sponge iron) of course (if purely eutectic), contains 4.3 per cent. C and 95.7 per cent. Fe, whilst the composition of the alloyed constituent varies. The analyses of the alloyed constituents (when carburised to the eutectic condition) in the eight cold-blast pig-irons are given in Table VI.

Table VI.—*Analyses of the Alloyed Constituents in Cold Blast.*

Nos.	1	2	3	4	5	6	7	8	Mean	Si free
Si in pig-iron ..	Per cent. 1.60	Per cent. 1.35	Per cent. 1.16	Per cent. 1.00	Per cent. 0.90	Per cent. 0.60	Per cent. 0.56	Per cent. 0.47	Per cent. 0.95	Per cent. 0.00
Si	2.96	2.87	2.70	2.61	2.80	2.41	2.24	2.00	2.65	0.00
Mn	1.66	1.59	1.62	1.70	1.78	1.69	1.88	0.94	1.62	2.59
P	1.11	1.21	1.25	1.30	1.56	2.01	1.68	2.21	1.40	3.10
C	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33

The carbon content in the two constituents, both of which are estimated as being in the fully eutectic condition, is shown in Table VII.

Table VII.—*Carbon Content in the Two Constituents in Cold Blast.*

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Si per cent. in pig-irons	1.60	1.35	1.16	1.00	0.90	0.60	0.56	0.47	0.95	0.00
Carbon in alloyed constituent	1.78	1.50	1.42	1.27	1.02	0.81	0.82	0.76	1.19	0.53
Carbon in unaltered eutectic constituent	1.96	2.27	2.44	2.63	2.91	3.22	3.22	3.26	2.76	3.60
Total carbon in eutectic pig-iron.. ..	3.74	3.77	3.86	3.90	3.93	4.03	4.04	4.02	3.95	4.13
Actual T.C. per cent.	3.12	3.10	3.11	3.15	3.16	2.90	3.00	2.73	3.04	—
Difference	0.62	0.67	0.75	0.75	0.77	1.13	1.04	1.29	0.78	—

The effect of the low hearth temperatures in the cold-blast furnace is shown by the low total-carbon contents, which are considerably lower than would be the case if the irons were truly eutectic. The mean analysis of the series is:—T.C., 3.04; Si, 0.95; Mn, 0.58; and P, 0.50 per cent. The total-carbon content is only 3.04 per cent., whereas the truly eutectic iron produced with higher hearth temperatures would contain 3.95 per cent. The two-constituent study of these irons shows that the sponge iron is carburised to only 68 per cent. of the carbon content required to form the eutectic.

The composition of the alloyed constituent in the cold-blast iron of mean analysis shown above is:—Si, 2.65; Mn, 1.64; P, 1.40; and C, 3.29 per cent.; where this constituent is of eutectic type. The estimations show that the sponge iron is only carburised in the furnace to 68 per cent. of the eutectic condition, and, therefore, contains only $0.68 \times 4.3 = 2.92$ per cent. carbon instead of 4.3 per cent.

One is thus able to visualise the structure of a cold-blast iron of about 1 per cent. Si, 0.55 per cent. Mn, and 0.50 per cent. P. It is virtually a mixture of 64 per cent. of hard tough iron (hypo-eutectic) containing 2.9 per cent. C, 97.1 per cent. Fe, and 36 per cent. of a eutectic iron of 2.65 per cent. Si, 1.62 per cent. Mn, 1.40 per cent. P, and 3.3 per cent. C contents.

Hot-Blast Pig-Irons of the "All-Mine" Type.

The Swedish and Staffordshire cold-blast irons so far considered may in each case be considered as being the product of "all-mine" or all-ore burdens. In the old days the blast furnaces working in any particular district were operated solely on ores or ironstone obtained from the particular district or location in which the furnaces were situated. In Staffordshire, for instance, an ironstone was mined along with the coal, many of the ironstone seams being mined from the base of the thick coal strata. In North Staffordshire the ironstone was called "potterymine" on account of its position in the Potteries area.

Wherever ironstone or ore has been obtained by mining operations in Britain, the blast-furnaceman using such ores in his furnaces without admixture of slag- or iron-bearing materials obtained from other districts, has classified the pig-iron as "all-mine" iron. Whether right or wrong, the old Staffordshire blast-furnaceman believed that the best pig-iron was obtained when the burdens consisted solely of Staffordshire ores or ironstones. If he had to use furnace tap-cinder from local wrought-iron making furnaces as part of the blast-furnace burden the pig-iron produced became known by the somewhat obnoxious term "cinder-pig," the market value of which was always lower than that of the "all-mine" iron.

"All-Mine" Hot-Blast Pig-Iron.

The author has studied the "all-mine" hot-blast type of pig-irons as commonly used in the foundry trade in the light of the two-constituent theory for purposes of a comparison with the English cold-blast pig-iron. The "all-mine" iron chosen for illustration is of hot-blast type, though the temperature of blast used is often below 700 deg. Fah., and it may generally be stated that the higher the blast temperature used in the furnace the higher is the total-carbon content in the pig-iron and also the higher is the silicon-content limit. (It will be noticed that genuine English cold-blast "all-mine" pig-irons rarely contain more than 1.8 per cent. silicon.)

Before referring in detail to the hot-blast all-mine irons it may be useful to compare the mean analyses of pig-irons of the three types alluded to in the communication.

(1) An English cold-blast series of pig-irons produced from the same group of furnaces, having a silicon range of 1.6 to 0.47 per cent.; (2) an English hot-blast series of pig-irons produced in a group of similar furnaces, having a silicon range of from 3 to 1 per cent., and (3) a Scottish hot-blast series of pig-irons produced from a group of similar furnaces, having a silicon range of from 3.25 to 0.5 per cent.

The mean analyses of the pig-irons produced are shown in Table VIIa on the facing page.

The influence of the blast temperature is seen in the progressively higher maximum silicon content, (1) series being produced in smaller furnaces than the other two. The rate of production in (2) and (3) series is, of course, higher than in the case of the cold-blast furnaces, the blast temperature being highest in (3) series. In the cold-blast furnace iron, the strongly hypo-eutectic character is seen by comparing the actual total-carbon content with that which would occur were the iron of fully-eutectic type. The higher manganese content of series 3 has some influence on the carbon content, tending to raise it, the higher silicon irons being hyper-eutectic in character, tending towards the "kishy" type, whilst the lower-silicon irons, below 2 per cent., are hypo-eutectic. The analyses of series 2, of warm-blast type, are shown in Table VIII.

The relative percentages of the two constituents in the above irons have been computed and are shown in Table IX.

The most interesting detail is that of the alloyed constituent which, when recarburised to the eutectic condition, has a carbon content of 3.33 per cent. The analyses of the alloyed constituent in each grade of iron are shown in Table X.

It will be noted that as the Si content is decreased the effect of the diminishing volume of the alloyed constituent is to increase the manganese and phosphorus contents in the constituent. The constituent becomes harder as the ternary phosphide eutectic and the manganese-carbide contents increase, particularly in the Nos. 4, 5 and 6 irons.

Sulphur.

Sulphur has been neglected in the estimations, but, as sulphur increases as the silicon and carbon decrease, the hardening effect of the sulphur will similarly increase in the actual pig-irons. Though MnS may be present in the alloyed constituent, the fact that the unaltered white iron (eutectic) constituent—which must

contain the harder FeS—increases in volume as the alloyed constituent decreases, points to the powerful effect of the FeS in hardening the metal structure. The "two-constituent" point of view throws much light on the mechanism of the combined effect of sulphur and carbon in the hardening of cast irons of low manganese and silicon content. In such irons the eutectic constituent occupies the bulk of the metal structure whilst this is being formed during the freezing period.

It is reasonable to conclude that most, if not all, the sulphur is originally present in the sponge iron before it is alloyed with Si, Mn and P in the furnace hearth. If, as in most cast irons of moderately-low Si and P contents, the remanent eutectic constituent contains most of the sulphur as FeS, Stead's contention that pure iron carbide will dissolve FeS and prevent it from graphitising supports the author's view that the Fe_3C of the eutectic constituent is the true hardener, aided by the Mn_3C and the Fe_3C in the ternary Fe.C.P eutectic when present in pig-irons low in Si content. The alloyed constituent always contains more than sufficient Mn to neutralise the hardening effect of the sulphur in this constituent, seeing that only the softer MnS is probably present.

(To be continued.)

Table VIIa.

Series No.	Si.	Mn.	S.	P.	T.C.	Estimated per cent. T.C. in fully eutectic irons.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
(1)	0.95	0.58	0.11	0.50	3.04	3.95 (cold blast)
(2)	2.00	0.76	0.07	0.57	3.27	3.56 (warm blast)
(3)	1.88	0.94	0.08	0.50	3.61	3.75 (hot blast)

Table VIII.—*Analyses of Series No. 2 (Warm Blast).*

Pig-iron Nos.	Si.	Mn.	S.	P.	T.C.	C.C.	G.C.	Esti mated T.C. in eutectic.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
No. 1	3.00	0.80	0.03	0.60	3.50	0.25	3.25	3.49
No. 2	2.50	0.80	0.035	0.60	3.40	0.40	3.00	3.59
No. 3	2.25	0.80	0.04	0.60	3.25	0.45	2.80	3.64
No. 4	1.75	0.80	0.04	0.60	3.25	0.50	2.75	3.84
No. 5	1.50	0.70	0.08	0.50	3.20	0.60	2.60	3.83
No. 6	1.00	0.65	0.10	0.50	3.00	0.60	2.40	3.95
Mean	2.00	0.76	0.064	0.57	3.27	0.47	2.80	3.56

Table IX.—*Relative Percentages of Alloyed and Unaltered Constituents.*

Pig-iron Nos.	1	2	3	4	5	6
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Silicon	3.00	2.50	2.25	1.75	1.50	1.00
Alloyed constituent	82.35	72.14	66.88	56.53	48.31	37.46
Unaltered primary eutectic constituent ..	17.65	27.86	33.12	43.47	51.69	62.54

Table X.

Pig-iron Nos.	1	2	3	4	5	6	Mean
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Si	3.64	3.47	3.37	3.09	3.11	2.67	3.22
Mn	0.97	1.10	1.20	1.41	1.45	1.73	1.31
P	0.73	0.83	0.90	1.06	1.04	1.33	0.98
C	3.33	3.33	3.33	3.33	3.33	3.33	3.33

New Carbide Cutting Tool.—A new carbide material under the name of "Ramet," in which tantalum-carbide and not tungsten-carbide is the hard constituent, has been placed on the market by the Fansteel Products Company, North Chicago, Ill., U.S.A. In this nickel is reported to be the main constituent. The new cutting material is mounted on tool shanks by the copper brazing method. It is stated that this new material is being used by over 75 plants of the full range of metals; that it has demonstrated its ability to cut 10 to 15 per cent. manganese-steel castings and such materials as bakelite, and that it cuts hardened high-speed steel.—"American Metal Market."

Sand Tests in the Foundry.

(*Concluded from page* 193.)

container is again full, when the water is drawn off as before. When all the sand what will pass the first sieve has been washed through, the sieve is removed and washing proceeded with in the second sieve. The process is continued as before until all the sieves have been washed. The sand remaining on each sieve is now washed into a measure. This should be much larger than the amount of sand on the sieve to allow for the settling of the sand and the decanting off of excess water. The sand settled in the bottom of the container is also measured.

The amount of bond in the sand is obtained by subtracting the total number of c.c. of sand left on the sieve and in the container from 100. These figures are again in percentage and 98 per cent. accuracy is obtained. The conversion to gravimetric figures is made, if desired, by finding out the weight of 1 c.c. of water-saturated sand of each grain size, and using 100 grams of water-saturated sand for the test.

Vibratory Sedimentation Tests.

These tests give instructive and interesting data and are very simple. When worked in conjunction with sieve tests they supply information that is not gained with the sieves. The sedimentation tests show the amount of very fine silt present, though the larger grains sizes are not shown up so well as they do not separate. The method is to obtain a number of bottles of the same size and shape, fairly long compared with cross-sectional area and holding approximately 400 c.c.

A measured 100 c.c. of sand is put in the bottle, which is nearly filled with water, corked and well shaken. The bottle is now placed on the vibrating plate. This consists of a flat cast-iron plate, above which a piece of sheet iron the same size is mounted on four holding-down bolts 1 in. longer than the height of the bottles and corks. The bolts are screwed and fitted with wing nuts. Into the bottom side of the cast-iron plate is screwed four pieces of $\frac{5}{8}$-in. dia. gas piping about 4 in. long. The tubes locate loosely over four studs about $\frac{1}{2}$ in. long in another plate or bench. A small compressed-air vibrator is belted to the side of the cast-iron plate. The bottles are then placed on the cast-iron plate and held tight by screwing the sheet-iron plate down on to the corks. The bottles are vibrated for 15 minutes after shaking up, and then allowed to stand for about 12 hrs. A gauge is made to fit under the bottom of the bottles and up one side. It is marked off in tenths, with the 100th division level with the sand in the bottle (100 c.c.). The thickness of the bands of sand grains, silt and bond, is read off and expressed as percentages.

Data Sheet of Sand Tests.

In order to condense the information gained from these several tests and make it possible to compare sands, Table V has been drawn up. Consignments of new sand and periodical tests of floor sand, etc., are subjected to all these tests and entered on this table. It will be seen that the tests are fairly comprehensive and give sufficient information for foundry control. It is quite realised that the gas content and elutriation tests for grain size are very useful. These are being investigated, but no standard practice has been evolved.

In conclusion, the author desires to thank Messrs. R. A. Lister & Company, Limited, of Dursley for giving their kind consent to the compilation of this Paper from the sand control carried on in their foundry.

The Story of Carborundum.

On March 4, at Sheffield, we had the pleasure of witnessing a very interesting film dealing with the manufacture of carborundum and "Aloxite," which indicates very impressively the part that these two important abrasives now play in modern engineering workshops.

The film opens out with the original experimental work that finally led up to the production of carborundum. The film then gives a good idea of the hydro-electric power development in Canada, and presents views of the electric furnaces at the Carborundum Company's plant at Shawinigan Falls, in which carborundum and "Aloxite" are manufactured. The carborundum crystals are formed at a temperature of about 4,000 deg. Fah., from such ordinary materials as coke, sand, sawdust and salt. The process of making "Aloxite" in the electric arc furnaces from coke and the aluminous clay bauxite is also shown. Views then show incidents in the transport of these abrasives across the Atlantic and their distribution in this country.

The film, which has been completely revised since a version of the same subject was shown some years ago, is excellently conceived and of great educational value, especially the numerous applications of grinding, both in heavy engineering and in mass production of intricate machine parts.

We understand that the film is being shown this week at Rotherham, Newark, Nottingham and Chesterfield, and next week at Halifax, Gainsborough and the Lancashire area.

Complimentary tickets for these exhibits may be obtained on application to The Carborundum Company, Limited, Trafford Park, Manchester.

The High Commissioner of South Africa, Mr. C. T. E. Water, on Monday, witnessed the loading at Workington, on the steamer "Dalia," of 7,000 tons of steel rails and sleepers rolled by the United Steel Companies, Limited, at Workington. It was the first shipment of the large South African rail and sleeper order that the United Steel Companies, Limited, secured recently.

The Sand Problem.*

By H. F. Coggon.

The title which has been given to these few remarks is very brief, but on closer examination appears to cover almost the whole field of foundry work.

As a matter of fact, just at the time of the invitation to give this Paper, the author's staff had several rather difficult matters under consideration, and each one had a special reference to foundry sands. It was "sand" all day for some time, and these circumstances suggested the title.

It is not proposed in any way to touch upon mineralogy, but rather to consider the sand problem as it affects the management of a foundry, the practical foundryman or moulder, and finally, the owners or shareholders who depend upon a return on capital for a livelihood.

The first consideration of the foundryman, or, in the case of a new foundry, the management, is to decide upon the kind or type of sand required for the moulds and cores. In consideration of this matter local conditions will play a very large part, and a choice will be made where the price of sand is low, and also where facilities are such that quick and guaranteed deliveries can be assured. All this is extremely important, but this Paper is based upon the position after the kinds of sand have been decided upon, ordered and delivered to the foundry. Having purchased the materials, the great opportunities of the management now present themselves, in so far as it devolves upon them to make the most efficient use of the raw materials which they have now received into their plant. The operations range themselves in the following sequence:—(1) Drying of sands; (2) mixing of core sands; (3) mixing of facing and backing sand; (4) drying of cores and moulds, and (5) handling and reclamation of used sands.

The drying of sand has been brought home to the consideration of foundrymen very dramatically during the last few years on account of the precision type of casting which the engineer is demanding. For different sizes, shapes and types of cores, a definite bond is required, particularly when it is in a green state, and therefore, when the casting to be produced has only a very small margin of error, it is essential for contraction purposes that the amount of moisture should be uniform and guaranteed. To prepare silica, or sea sand, delivered at various periods of the year without moisture test, is courting disaster, and it is only common sense that this varying factor should be definitely ascertainable when the sand is first brought into use in the foundry, and the only means of accomplishing this, with any degree of surety, is by drying out all the moisture before delivering the sand to the core mixer.

Having dried the sand, it is now passed forward for the addition of moisture and bond, and then to the mixer. The mixing of core sands is a most important operation, the action of the machine must be such as to disturb the grains of sand very quickly, producing at the same time a complete feeding of the whole charge in the path of the muller at least once every revolution. The muller should be of sufficient weight to ride on the layer of sand to maintain a squeezing and not a crushing action, so that the bond is uniformly distributed over each grain of sand. The mixed sand is then discharged from the mill and passed forward to the core maker, who shapes it into cores.

* A Paper presented at a meeting of the Newcastle-upon-Tyne and District Branch of the Institute of British Foundrymen, Mr. A. Logan presiding.

Facing and Backing Sands.

With facing and backing sands it is an advantage slightly to increase the pressure on the charge, but it is likewise essential to have a very quick and intensive displacement action created in the mill; a thorough mixture bringing out the required bond can be more efficiently produced in a comparatively short time if the above points are maintained. A further treatment is required for these types of sand, namely, aeration and disintegration, and it may be stated that backing sand definitely improves upon aeration, but with facing sand a complete disintegration is demanded.

The backing and facing sand is now handled by the moulder, the core maker exercises his skill in forming a core, and finally, according to the type of work, the mould and the core may require to be dried, after which all is ready for these two sand structures to be put together ready for the molten metal.

All is now ready for the metal to be cast, after which the boxes, sand and castings have to be dealt with (by hand or mechanically), the boxes and sand re-entering the system, the castings passing out of the foundry.

The preparation of sand is mostly entrusted to the moulder and his labourer or handled mechanically, and moulds and cores eventually made for the next cast. In many foundries today the moulder spends 20 per cent. of his time in sand preparation and labouring, even when up-to-date and efficient moulding machines are in use.

Whilst the core maker is generally relieved of the responsibility for mixing the core sands, in numerous foundries up and down the country one can daily witness core makers walking from the benches to the drying ovens, putting in an odd core or two, and bringing out those cores already dried and required by the moulder. The loss of output, the waste of fuel, and obvious lack of organisation all increase labour and material costs and keep production down.

The scientific investigations carried out by the British Cast Iron Research Association afford very welcome and interesting and valuable practical data to the British foundryman. The views expressed by Sir Harold Hartley at the luncheon following the annual meeting of the British Cast Iron Research Association, when he stated that the practical service available to the British founding industry is unequalled elsewhere, are emphatically correct. Is the British founding industry taking full advantage of this opportunity?

Sand is the first raw material; it constitutes the greatest incidental weight handled per ton of castings produced, and its condition when moulded or cored will determine the quality of the ultimate product. Research work and practical experience give reliable formulæ for sand mixtures. To give the best results mixtures must be sand mixtures and not foundry "all-sorts." It is suggested to the foundrymen that a vast field of remunerative development lies in the following directions: (1) Sand handling in core and moulding operations. By carefully designed handling methods, output can be increased materially, but, most important of all, the sand will be consistently uniform in its character, so that one can rely upon equally uniform results. (2) The handling of returned sand and its reclamation. Mechanically, this sand can be quickly transported, increasing the productivity of floor area, removal of all iron, etc., and removal of fines, thus reclaiming the maximum amount of good usable backing sand in its very best condition. New sand can be added, coal dust passed into the system at a predetermined rate, and a perfectly homogeneous backing and facing sand returned to the moulder.

What the Sand Problem Means.

Does the founder realise what this sand problem involves? The input of new sand to the industry will probably reach a figure of 1½ million tons per year, two-thirds of which could be reasonably accepted as new facing sand. On a very conservative estimate thirty million tons of sand are handled every year inside the iron foundries of Great Britain, involving laborious work, creating distinctly unhealthy working conditions, and costing a great amount of money.

It is conceded on all sides that mechanically-prepared sands are more consistently uniform, and this enables a management to progress by way of experiment under working conditions. Where the human factor has to be allowed for, discrepancies in results are more difficult to trace and rectify. Why should the industry impose upon its workers physical fatigue which in no way assists production?

Before an iron foundry producing approximately 47,000 tons per year was re-equipped with mechanical plant, the total number of employees in the foundry was over 1,300; at the present moment they do not reach 600. The author recently had an opportunity of perusing a reorganisation scheme for a weekly output of just under 600 tons of iron castings, the most interesting feature of which was the reduction in foundry area by one-third, and it was very attractive to the concern because of the fact that they were requiring a new building of approximately the size discarded by the foundry.

Two examples of the results of mechanisation of the sand plant have been certified by the management; the first refers to a steel foundry, wherein the total capital expenditure of £500 was recovered in 16 months and the second, an iron foundry, wherein it required but nine months to recover a capital expenditure of £385. The above returns in the present depressed condition of the industry open a field for new finance, showing a most extraordinary return.

Invested Capital of the Industry.

It must be conceded that to ascertain the capital investment in the iron-founding industry is an almost impossible task in view of the large number of firms operating a foundry as part of their organisation. However, two concrete cases have been taken where iron founding only is carried on. In one case the capital investment per ton of iron produced per year is £16. Another case was taken, which is a very extreme one indeed, and represents a small foundry operating practically without any staff, the owner of which runs the job himself, enjoying a very steady local trade of long standing; thus securing all the advantages of an extremely low investment figure. In this case it works out at £6 per ton. Several other investigations gave a figure well above the former one of £16.

Taking an average of £11 per ton as a financial investment on production, which can be considered a very conservative estimate, then with an average tonnage of three million, an invested capital of thirty-three million sterling gives us the grand total for the industry. The Government, banks and financiers only seem to be interested in millions, or always talk of millions, and the founding industry certainly provides them with an opportunity of using some of the idle money, about which we hear so much to-day, to advantage. To undertake financing solely for the provision of modern efficient equipment in the iron foundries of Great Britain, the banks and financial houses of this country would be doing some really solid work; employment would benefit tremendously. It is preferable to give this industry that opportunity to provide work, as bridges, new roads, and the like cannot be exported or made to pay

dividends. Again, the chaos created by such irrelevant labour makes clean and healthy conditions difficult. Only one conclusion is possible, and that is, the sand problem offers in its solution the greatest possibilities in the founding industry for mechanicalisation.

Mechanisation a Cardinal Factor.

The real problem in a foundry, therefore, would appear to be the handling of sand in all its stages. Mechanicalisation or, as the National Conference were pleased to call it, "mechanisation," will eliminate undesirable conditions and unnecessary labour; for the sake of clarity it should be stated that there is no envisaging of the dismissal of wage earners, but merely a re-direction of labour's efforts into more profitable channels. Mechanisation enables a greater output to be accomplished without increasing the floor area. This reduces to some extent overhead charges, under the present-day local and national taxation, and materially assists in a more efficient supervision by the management and foundry foremen. Mechanisation will give increased output and at the same time a better product, at a cost which would enable this country to meet competition successfully from the view point of the two great partners in industry—capital and labour.

A well-known Yorkshireman once said that the engineer was the greatest of all social reformers. This surely is a truism. The engineer is relieving domestic life of its drudgery, and why should he not be able to relieve the foundry life of its drudgery? In industrial life people are constant adopters of his activities, and accept his contribution to their pleasures. Founders cannot stand by and be disinterested; they must actively take part in his work. Individually, or collectively, no nation can withstand progress; mechanisation spells employment, and every industrial country proves this to an amazing degree.

Marshal the facts in relation to industry from 1914 to the present moment, and it is difficult to deny that the war costs lay heavily on this country. Further, more than half the peoples of the world have been busy fighting each other since the war instead of working together, producing and trading. The founding industry is probably on a 45 per cent. basis of production, but as world conditions become more settled there is no reason why it should not return to its pre-war position in the industrial world.

Listening to the wireless a few days ago, a speaker, who had been up North to investigate the state of trade, declared that the textile industry would never again be able to take the unemployed back into its ranks. It is unbelievable that any responsible industrialist can have lost faith to such an extent. When one admits his inability to provide work his book is closed. If that M.P.'s statement were the true expression of outlook as regards the industrialist generally, it would be better for industry and this country to pass the reins of control on to those who to-day hold the same faith in the future as that which made this country an industrial world power. Mechanisation is a cardinal factor, and has been for hundreds of years; it cannot be checked seriously, and human nature itself responds eagerly to its appeal.

DISCUSSION.

Mr. Victor Stobie opened the discussion by asking Mr. Coggon on what basis the iron and the steel foundries, of which he had made the comparisons between the old and new methods, had been working before, so that they could realise how those economies had been produced.

Mr. Coggon replied that in the case of the steel foundry the sand was being handled from a bin, in the immediate vicinity at floor level to the mixer, from the mixer to an aerator, from the aerator into steel tubs at a point where the crane could conveniently transport them. With the plant installed, the sand was brought right up to the plant and it was mechanically handled, mixed, aerated and discharged into buckets directly under the crane without any man labour at all. The saving was not only on labour, but on power charges. In the iron foundry the same conditions resulted in the saving, except that they reduced their sand bill by 50 per cent., the percentage of new sand added to the mixture being halved when put through the plant he had illustrated.

Mill Operation.

Mr. W. Scott said that he had noticed that the mill shown on one of the slides had very narrow and parallel rollers. That to his mind was against correct mixing, as the inside of the roller was the same circumference as the outside, and he thought that would result in a skidding action. Why was there such a large space from the roller itself to the outside of the mill? The sand could lie in that space without being actually treated, if it was only in the mill 3½ minutes.

Mr. Coggon stated that there was practically no skidding action of the muller on the sand. The muller ran on ball bearings and with core sands it merely lay on the sand, not resting on the bottom of the pan at all. With facing sands, where they wanted to bring out the bond, every particle of the sand passed from the centre of the mill to the outside three times to every revolution of the mullers and they revolved twenty-eight times per minute. The action of lifting up the sand quickly brought out the bond much more quickly and efficiently than just milling. There was no rubbing or crushing action.

Hopper Design.

Mr. C. Gresty asked Mr. Coggon if he could tell them something of the design of the hoppers, particularly of those which they had seen immediately over the moulding machine. He had been in one foundry which had had a number of moulding machines fed by hoppers, and they bore distinct signs of hammering through the sand being jammed. He thought there must be something lacking in the design. Another foundry had actually cut out the hoppers over the moulding machines. Another point which had struck him particularly rising out of Mr. Logan's remarks was that in the Newcastle district there were not very many directions in which continuous casting could be used. Had Mr. Coggon any suggestions to make as to how the old sand was going to be brought back to the milling plant in an ordinary jobbing foundry, particularly one dealing with castings from ½ cwt. up to 20 tons, where a considerable area had to be devoted to knocking out?

Mr. Coggon said that, with reference to the design, it depended entirely upon the moisture content of the sand as to the type of hopper used. In some cases cylindrical hoppers were used, but he had known no case where it was essential to use that type. It was difficult to explain in detail exactly the design of a hopper, as each job had its own particular size and shape. He knew of a hopper operating on backing sands, with a capacity of 50 tons per hour. There was a machine plant at the bottom of the hopper with a revolving regulatable discharge plough, and, providing the moisture content of the sand was correct, there was no difficulty experienced with the hopper and it was rather a guide to the management, because, if the hopper choked up, they knew that something was wrong with the sand. He had seen several plants, however, where a hammer had been used, also vibrators attached. If the sand passing through the system was perfectly consistent there would be no difficulty in discharging it at any rate which was desired. With regard to Mr. Gresty's second point, there were quite a number of jobbing foundries which place their plant in the foundry at the point where the largest quantity of sand was knocked out. They brought the plant to that position and then discharged for floor work from that central point. It was rather a difficult point to discuss without the lay-out of the foundry.

Mechanical Breakdowns.

Mr. Gresty further questioned Mr. Coggon as to whether any provision was made for a mechanical breakdown in an ordinary continuous-casting plant. Did they provide any duplication of essential parts? What happened supposing the conveyor stopped? Mr. Coggon asked Mr. Gresty whether he was referring to the mould conveyor or the sand conveyor. He replied that he was thinking of the mould conveyor.

Mr. Coggon said that with a properly-designed mould conveyor there was no reason why it should fail without giving plenty of warning. It was of fairly simple design, but had to be robust. He did not know of a case of a mould conveyor stopping where skilled supervision had been exercised. With regard to the sand conveyor stopping, they overcame that in the following way:—They had storage hoppers which would keep a plant going for the maximum time it would take to correct the most serious accident which could happen. They did not provide any duplicate parts.

Mr. Shaw said that he understood that the hoppers were at intermediate points. How did they actually function over moulding machines which were dotted about over the shop? If the conveyor portion failed they would not be able to get the sand out of the hoppers without manhandling it.

Mr. Coggon replied that the final storage hopper was generally immediately in front of the conveyor feeding the machines, and they sometimes made provision for storage in the hoppers above the machines, so that if the conveyor failed there would be enough sand to carry on with.

Maintenance Costs.

Mr. W. J. Paulin said that it was evident from Mr. Coggon's Paper that the running of a foundry of that description called for a considerable amount of extra engineering work, and the conditions under which the plant was running, in spite of his comparison with the machine shop, he thought it could hardly be reckoned at all equal. For instance, at one part of the roundabout there was the knock-out and the subsequent flying about of fine dust. That dust would settle on the running mechanism. There was a difficulty in the period of time of supplying the core from the moulding sand, which seemed to be always a difficult job, and any mixing of oil-sand cores with the moulding sand appeared to be fatal, for the resulting possibility of bond, and would seriously affect the necessary introduction of the new sand to restore the condition. In order to avoid much of the wear and tear, special precautions would have to be taken. For instance, in the running of machines, all motors should be fully enclosed in order to protect them from the sand and dust. Mr. Coggon had mentioned that, in order to facilitate handling, ball bearings were introduced into the core oven. They would be unable to oil the bearings, and, therefore, the balls would have to run dry. It seemed to him that the amount spent on maintenance and spare parts would be very great indeed, and he would like to know whether the figure given by Mr. Coggon included all the wear and tear which was bound to take place from the introduction of special machinery of that type. Mr. Gresty had already mentioned the possibility of using that system effectively to obtain a genuine return for all the outlay, was not at all likely in the works in the Newcastle district. For instance, if they took works dealing with auxiliary engines, there was a considerable variety of castings produced, and it seemed to him that the chances of laying down a scheme like that would be very limited. Mr. Coggon's statement that such mechanisation was the opportunity for making another bid for world supremacy, hardly carried conviction.

Many of the machines appealed to him and they could perhaps be applied with advantage, but the roundabout seemed to be limited in its application.

It was not very clear how Mr. Coggon intended the aeration of sand to take place as it issued from the mill, and he had to admit that he felt the same difficulty as Mr. Scott had in understanding why the rollers in some cases had a bigger diameter on the inside; there was bound to be sticking somewhere. It would be apt to crush the sand grains into smaller crystals than were suitable for moulding, and eventually affect the opportunities for ventilation.

Simple Plant Saves Money.

In reply to Mr. Paulin, Mr. Coggon said that ample provision was made in the system at the knock out for the extraction of fines and gases as far as possible outside the foundry altogether. There was an extraction plant placed at that point in order to keep the foundry clear of fines and gases. With regard to the rollers on the core-oven rack, the ball bearings worked perfectly satisfactorily. In a core oven the temperature was not specially high, and there was every opportunity for keeping the bearings properly greased and lubricated; they were greased every morning. It was obvious that a continuous-casting system such as that he had illustrated had its restrictions. It was useless in a jobbing foundry where there was a great difference in the weight and size of the castings, but within certain limits they were not restricted to the size and weight of casting. The figure he had mentioned included foundry engineers' wages. In the last case it included the wages of two foundry engineers, whose duties were to see that the plant was properly maintained, and their wages had been saved many times. In the case of the iron foundry, they had saved the total cost of the plant in nine months, *i.e.*, £380. It had now been working three years, and, taking all repairs into consideration, that saving had not been considerably reduced.

The plant in question consisted of a sand mixer, a bucket loader, aerator and storage hopper. With reference to the rollers, Mr. Coggon stated that the photograph was perhaps a little misleading. At the time the photograph was taken that mixer had actually produced 33,000 tons of backing sand, and had not been renewed at all. The mullers might appear to be of different diameter, but they were polished and had worn slightly. He had not anticipated the question concerning the skidding or crushing action. If he had done so, he would have brought the figures given to them by the British Cast Iron Research Association on some rather lengthy tests which proved that the mill did not in any way break up the sand structure. Immediately below the discharge of the mixer was a drum with blades on revolving at about 900 r.p.m., and the sand fell into the drum and was thrown on to the cover of the aerator and was finally discharged.

Disintegration and Aeration.

It was pointed out by one of the members that Mr. Coggon had differentiated in his Paper between disintegration and aeration. He would like to hear what Mr. Coggon had to say on that point, because if the sand was properly disintegrated, it would be aerated at the same time.

Mr. Coggon explained that with packing sands and certain facing sands aeration was quite enough. With special facing sands, however, little pellets of red sand came through the mill or aerator with aeration only, but after disintegration all those pellets were broken up. Sand was not aerated after it had been disintegrated unless it was going to be stored. After being stored it was necessary to aerate it again.

Mr. Simpson said that Mr. Coggon had in one place shown sand being aerated before it was milled. Mr. Coggon replied that possibly Mr. Simpson was confusing facing and backing sands with core sands. Core sand was crushed, but not aerated. Mr. Paulin said that he had been under the same impression as Mr. Simpson.

Mr. Shaw said that in one of Mr. Coggon's diagrams at least four places were shown where the sand was aerated as it passed through the system. What was the reason for that?

In answer, Mr. Coggon said that at each of those four points were large storage hoppers, and the sand was aerated in order to guarantee its condition after storage. The company who had installed the plant insisted on aeration at each point, but he did not know that it was essential.

Regulating the Discard.

Mr. A. Logan said that, taking the type of plant which they had seen illustrated, which would be the plant used for continuous-casting processes, they found that the sand went round in a circle. It was prepared by the sand mixer, etc., and delivered to the moulding machines. The moulds were made, cast and knocked out, and the sand was fed back into the sand mixer again. At what point did they discard old sand and how much was discarded? Mr. Coggon had once or twice mentioned the removal of fines, but he had not indicated how that was done. Once the sand plant was established, was it merely a matter of routine work to run it or were any practical tests made to keep a check on it?

Mr. Coggon replied that in some plants an extraction plant was installed at the point where the sand was discharged from the screen to extract all fines. In the large continuous casting plant which he had illustrated the extraction plant was situated at the knock out. The fines were extracted by air. It was possible to cleanse the sand thoroughly if a properly regulated current of air passed through it. Air was drawn across the sand by the extraction plant; as the sand fell from the casting a current of air, which was balanced, passed through it and withdrew all fines. No difficulty was experienced in that regard. Five per cent. of new sand was added at the point where the returned core sand and the moulding sand passed through the main feeding conveyor to the mixing plant. Samples of the moulding sand were taken as it passed to the machines, these samples being taken to the laboratory once a day for testing, in order to see that the permeability of the sand was in the very best condition for that class of work.

Grinding and Rubbing Action of Mills.

Mr. Stobie, returning to the question of the parallel rollers in the mill, said that, personally, he thought they would be an advantage. Mr. Coggon had pointed out that the mullers were always a certain distance from the bottom of the mixer, in order to prevent the sand grains being crushed. He saw an advantage in that, for, if the rubbing action was increased, it should give a better bond.

Mr. Coggon said that from actual practice tests over a long period of time, an average of less than 2 per cent. reduction in the grain size was obtained. He did not know of any other type of mill which gave so slow and so small a reduction of grain size. It proved that that type of machine did not grind the sand. Several mixtures were taken over a period of time, and gave the same average result.

Mr. Logan said that Mr. Coggon had mentioned the time of milling as 3½ min. He thought that that time would hardly be considered sufficient in the light of knowledge which had been obtained now. The British Cast Iron Research Association work pointed to rather longer than that. Had Mr. Coggon any figures for the results of ten minutes' milling?

Mr. France said that he had not seen the report on that particular point, but it seemed to him the whole point was what kind of sand was used. It might be that with a different type of sand ten minutes' milling would be necessary.

In reply to a question put by Mr. Shaw, Mr. Coggon said that both narrow and wide rollers could be obtained for the different sizes of mills. With reference to the skidding action, with one patent mixture they had had in operation a large mill with mullers weighing 50 cwts. each, and the skidding action created a temperature which gave them the required bond very quickly. They had increased the weight of the mullers so that the same weight per sq. in. as in the larger mill was obtained, but that did not do the job.

Wear of Ploughs.

Mr. Scott asked if that scraper wore out rapidly; the only thing they had found to give satisfaction was a mild steel, case-hardened on that surface. Mr. Coggon said that they had tried manganese steel, cast steel, grey iron, etc., and they found that manganese steel would not last as long as grey iron with sand. The cost of the scraper was so little that they continually renewed them and kept the plant efficient.

Mr. Logan said that it had already been suggested that they had not the type of work in that district which demanded a continuous plant of that kind. He would like to hear what Mr. Coggon had to say on the subject with reference to an ordinary jobbing foundry as they knew it in the Newcastle area. Would it be beneficial to instal a single unit such as the sand-mixing plant, and would the cost be saved in nine months?

Mr. Coggon said that there were already several in the district. The sand plant was installed in the shop adjoining the jobbing foundry and all the sand was brought to that central plant for mixing ready for passing back to the foundry. The plant had been found to be efficient, and on the results obtained on it in a jobbing foundry the plant instanced, which had saved £380 in nine months, had been installed. The castings produced by that foundry varied from 1 cwt. up to 5 cwts. It took one man to operate the plant. There was a saving in labour, as the sand used to be mixed in all parts of the foundry; there was also a saving in new sand. The face of their castings had been considerably improved since the sand had been put through that plant.

A vote of thanks was proposed by Mr. Scott and seconded by Mr. Simpson, to which Mr. Coggon briefly replied.

Continental Steel Cartel.

The committee of the Continental Steel Cartel met in Paris recently and decided that the rate of production in the present month should be maintained on the level of that in January and February. A further meeting was held at Düsseldorf this week, with the object of fixing the output in the second quarter of the year. Concerning the future of the Cartel, it is noted that a scheme is under consideration for dividing up the quota of each member-group into home and export contingents, as is already done in the case of Germany and France.

A Quality Test for Tool Steel.—According to Mr. Ragnar Arpi in "Jernkontorets Annaler," a rapid method of testing the quality of a tool steel should be simple and give distinct and reliable results. Existing methods of rapid testing have not been found to fulfil these requirements. The object of the author's investigation was to ascertain if the fracture of specimens quenched from different temperatures gave a reliable indication of the quality of the steel. The specimens were compared with a scale of 10 fracture classes, where 0 designated a very coarse-grained fracture and 10 the finest fracture obtainable. Experiments have been carried out on different materials at several Swedish steel works. The method is very simple, and it is not difficult to classify the fractures, but the method has not been found to be entirely reliable. While steels with a wide quenching range (fine-grained fracture at widely differing quenching temperatures) also show good results when practically tested as tools, a narrow quenching range may not necessarily mean inferior quality.

Trade Talk.

Messrs. Hall Russell & Company, Limited, Aberdeen, have received an order for a collier, to cost about £20,000, from the Northern Co-operative Society, Limited.

The imports of foreign iron ore at the Prince of Wales Dock, Workington, in February amounted to 16,500 tons, compared with 9,000 tons in January and 9,430 tons in February, 1930.

The Great Western Railway Company has recently placed contracts to the value of £50,000, including one for 30 sets of engine tanks and bunkers with Messrs. Ruston & Hornsby, Limited, Lincoln.

An extraordinary general meeting of the Renold & Coventry Chain Company, Limited, of Coventry, was held on Tuesday to consider a resolution to increase the capital to £1,200,000 by the creation of 100,000 shares of £1 each, to be issued at the discretion of the directors.

The Tabor Manufacturing Company, of Tacony, Philadelphia, has purchased the business of Titgen-Eastwood, also of Philadelphia. This means that the Tabor Company will now operate a complete line of foundry equipment, including cupolas, sand-blast, rumblers, blowers, and the similar material.

A bursary of the value of £25 per annum, tenable for four years in any Faculty of the University of Glasgow, is being offered by the Singer Manufacturing Company, Limited, of Clydebank. Candidates must either be employed in the Singer works or be the sons or daughters of employees, and application must be made before April 30. The award will be made on the results of the University General Bursaries Competition, to be held in June.

The Ajax Metal Company, of Philadelphia, has organised two subsidiary companies—the Ajax Electric Company and the Ajax Electric Furnace Corporation. Mr. G. H. Clamer, a Past-President of the American Foundrymen's Association, is to be President of both. The first-named company will export resistance furnaces developed by the Electric Furnace Company, Limited, of London, and the second the high-frequency melting plants.

The Wellman Smith Owen Engineering Corporation, Limited, have recently received from Messrs. William Beardmore & Company, Limited, Parkhead Steelworks, Glasgow, an order for a Wellman-Soward patent continuous reheating furnace for their tyre mill. The furnace will be capable of heating 5 tons of ingots per hour. Three of these patent furnaces have been installed at Messrs. Taylor Bros., Trafford Park Works, Manchester.

Messrs. Ferguson Brothers (Port Glasgow), Limited, have launched the twin-screw steamer "Trinidad" for the Crown Agents for the Colonies for service at Trinidad. The machinery consists of two sets of reciprocating engines and marine-type boilers, with Wallsend-Howden oil-fuel forced-draft installation. Messrs. Lobnitz & Company, Limited, of Renfrew, launched the dredger "Pylcomayo," built to the order of the Chilian Government. In this vessel the four sets of three-cylinder triple-expansion engines are so arranged that all can be used for propelling or for pumping, or two can be used for propelling and two for pumping when using the drag suction. A new motor tanker, "British Resource," built by the Greenock Dockyard Company, Limited, for the British Tanker Company, London, has completed trials on the Clyde.

Messrs. Hall & Pickles, Limited, of Manchester and Sheffield, have decided to build a new works for the manufacture of high-speed steel at Ecclesfield, Sheffield. A site of about 45 acres has been acquired, and they are commencing to build a small unit there, with the idea of future development. The first unit will consist of Ajax-Northrup high-frequency melting furnaces, for the manufacture of high-speed steels of the highest qualities, and also various alloy steels. A melting shop of modern design will be erected, and a reinforced-concrete road will be build from the main road to the furnace building. There will also be a suitable electricity sub-station, to contain a motor generator set, for which power will be obtained from the Yorkshire Electric Power Company, Limited. Meantime, other operations, as regards grinding, annealing and finishing of high-speed steel, will be continued at the firm's present works at Bessemer Road, Attercliffe, Sheffield.

The Electric Furnace Company, Limited, of 17, Victoria Street, London, S.W.1, has received an order for a 28-cwt. Ajax-Northrup high-frequency furnace for a French firm, who had already in operation one 28-cwt. and four smaller furnaces of the same type. Recently a 28-cwt. furnace lining made by the Rohn process produced 228 heats for an average power consumption of 622 kw.-hrs. per ton. These results, obtained when making alloy steel from good raw material, prove the economy of the process. The complete plant will have a capacity of about 20 tons per 8-hr. shift, and is by far the largest installation of high-frequency furnaces yet made. Almost the whole of the equipment has been, or will be, manufactured in Great Britain. Orders have also been received for high-frequency furnaces from two Sheffield steelworks. Since the first commercial Ajax-Northrup furnace in this country was erected, three and a-half years ago, 28 of these furnaces, of from 100 to 650 kilowatts each, have been supplied by the Electric Furnace Company, Limited, in England and France.

Discussing international trade at University College, Cardiff, recently, Mr. William Graham, M.P., President of the Board of Trade, said that the great bulk of present-day unemployment was found in the coal, iron and steel, shipbuilding and engineering trades, and especially in the cotton-textile industries. Save to some extent in iron and steel, the tariff controversy did not appear to have any immediate bearing on these industries. For Great Britain coal was largely a European problem, and the organisation of the industry in this country was still a painful and laborious enterprise. To be effective the Coal Mines Act of 1930 would require to be greatly developed; and it had always been specified that special facilities would require to be provided for the export trade. That, however, raised the question of European agreement, towards which he trusted that steady progress would be made among European coal producers, designed to secure a fair price for their commodity. In the long run it might involve an allocation of the European market. The iron and steel industry requested what was in effect a prohibitive tariff. Its present plea was that the whole of the 3,000,000 tons of imported iron and steel in Great Britain could be manufactured in this country, but it was clear that no complete prohibition could be offered by any Government, whatever its fiscal policy. To a large extent the imports of iron and steel were the raw materials of other industries; and the prohibition would be ineffective if it did not raise the price of the home article. An elaborate system of drawbacks would be almost inevitable.

Personal.

Mr. R. W. McAdam, Principal of the Greenock Technical School, has resigned consequent upon his appointment as Principal of the Acton Technical College under the Middlesex County Council.

Mr. A. W. Ironside, recently business manager of the Harland Engineering Company, Limited, Alloa, has returned to the Vaughan Crane Company, Limited, Openshaw, Manchester, as director and general manager.

Mr. Robert Lowe, A.M.I.Mech.E., who was formerly representative for Messrs. Kryn & Lahy (1928), Limited, has joined the Lowmoor Foundry, Old Works, Lowmoor, Yorks, as technical representative, with offices at 3, Victoria Street, Westminster, London, S.W.1.

Will.

Grace, J. E., a director of Ferrous Light Castings, Limited, ironfounders, Warrington £4,790

Obituary.

Mr. Charles de Wendel, formerly a leading member of the Comité des Forges (the association of French ironmasters), died recently at Touraine, aged 60.

Mr. William J. Evans, who entered the steel business in this country fifty years ago and went to America in 1888, has died at the age of 70 years in Pittsburgh. He was the Pittsburgh agent of the Titanium Alloy Manufacturing Company, Niagara Falls, N.Y.

British Steel Mark.

At a luncheon given at the Hotel Victoria, Northumberland Avenue, London, by the British Steelwork Association, on March 3, Mr. J. H. Humphreys in the chair, Sir Wm. J. Larke, K.B.E. (Director of the National Federation of Iron and Steel Manufacturers), outlined the following scheme for identifying British steel.

Briefly the scheme consists of the mark shown in the accompanying illustration being rolled on all British steel. That, of course, necessitated the marking of all British rolls, which, as Sir William pointed out, would take a certain amount of time, but it would be reasonable to assume that after 1931 all steel which was not so embossed, was not of British manufacture. It was anticipated that as a result of the scheme, results beneficial to the British steel industry would accrue.

In spite of various efforts, however, the importation of foreign steel continued to flood the home market, and there was a corresponding reduction in the output of British steel.

The supply of foreign steel by merchants to buyers who anticipate receiving British steel,

Mark adopted by Steel Manufacturers in Great Britain to indicate British Steel.

or at any rate British quality, represented unfair conditions to the buyer and to the British steelmaker, and as such conditions were frequently brought to the notice of the latter it was his intention to rectify this position by making public the full implication of such trading and to supply the buyer with the means whereby he might identify his purchase.

In the past there was more than sufficient excuse for errors in supply, as it was a common practice of foreign manufacturers to roll on their steel the letters "B.S.," followed by particulars of the sizes. The letters "B.S." represented "British Standard" sizes as distinct from metric sizes, and not "British steel" or "British standard" for quality. It would, therefore, be easily understood how these letters conveyed to the uninitiated a false indication of origin.

It was the intention of the steel industry in adopting the new British steel mark to circulate widely information respecting the relative qualities, and hence values, of British and foreign steel. It was hoped in this way to reduce the importations which were doing so much harm to the basic industries of coal and steel, and increasing the figures of unemployment.

Success would depend greatly on the support which architects, engineers and users generally throughout the country would give by specifying British material and insisting on steel with the new British steel mark. The employment of British steel would mean the employment of British workers, not only in the actual manufacture of the steel itself, but in raising the necessary coal, iron ore, limestone, etc. If the steel were made entirely from British iron ore, the production of a million tons of steel would give employment to 40,000 men for one year in raising the necessary coal, iron ore, limestone, etc., in assembling these materials, and in manufacturing them into steel. If the iron and steel which had been imported in the last few years had been made in this country, therefore, our numbers unemployed would have been at least 120,000 less throughout that period.

Mr. Arthur Pugh also spoke.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—In this area there are no very definite indications of an expansion in the demand for pig-iron. It is believed that local foundries have booked certain orders which will involve a bigger consumption of pig-iron, and there are a few inquiries for the second quarter of the year, but these are largely discounted by other less satisfactory considerations. Deliveries to Scotland show a marked contraction, and there is no doubt that in many Scottish works, Indian and Continental pig-iron is supplanting Cleveland iron. Exports continue to decline, and the area of distribution of Cleveland iron has seldom been so restricted. Moreover, consumers are reluctant to discuss forward contracts. However, the dull tone which has prevailed on 'Change of late was just a little less noticeable in the past week, although business still proceeded on cautious lines. Fortunately the unsold surplus of Cleveland pig-iron in this area is not large, and, when an expansion of business does take place, it may necessitate the prompt restarting of more blast furnaces. Apart from the Scottish area, the fixed minimum quotations are:—No. 1 Cleveland foundry iron, 61s. per ton; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton.

The position of hematite is no better. Only six blast furnaces are now producing East Coast hematite, and apparently they are sufficient to cope with all current industrial requirements. Export sales are more difficult to negotiate, and, although the British works are taking regular deliveries under contract, new business is almost exclusively restricted to small parcels for early delivery. Prices are still irregular. Hematite makers are now prepared to accept 68s. per ton for East Coast mixed numbers, and 68s. 6d. for No. 1 quality. Persistent buyers have been able to purchase odd lots from merchants at these figures for some time. In the North-West of England, Bessemer mixed numbers are quoted at 68s. per ton at works.

LANCASHIRE.—The slight improvement noted last week in the tone of this market appears to be maintained. Makers have experienced a rather better flow of orders during the past week, although consumers in this district are still averse from contract buying for any distance ahead. The position of textile machinery and other heavy foundries is not so good, but there seems to be less complaint locally from certain branches of the light foundry trade making specialty products. Prices are as follow:—Derbyshire and Staffordshire No. 3 foundry, 69s. 6d.; Northamptonshire foundry, 68s.; Derbyshire forge, 64s. 6d.; North-East Coast foundry, 71s.; Scottish foundry iron, 90s. to 91s.; West Coast hematite, 82s. 6d., all per ton delivered Manchester.

MIDLANDS.—No improvement can be discerned in the demand from ironfounders in the Midland area. Orders representing any tonnage are exceptional, and consumers are content to place sufficient business to cover only immediate needs. There is no improvement in the demand for forge pig-iron, of which good stocks are carried. The prices quoted by the furnaces for delivery to Birmingham and Black Country stations are 67s. 6d. for Northants No. 3, and 71s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—The volume of business being done in the Scottish pig-iron trade is lamentably small. The shipbuilding returns for last month show why the engineering founders are practically all at a standstill, while the light-castings section is also quiet. Unfortunately there is no sign of any change for the better, the seven furnaces operating here being more than ample to supply the needs of the trade. In some cases works are being closed for varying periods. The price of Scottish foundry iron is 73s. 6d. per ton f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1. Middlesbrough iron remains in limited demand. Continental No. 3 can now be obtained at 53s. 6d. f.o.t. Grangemouth, against 60s. for No. 3 Middlesbrough.

Finished Iron.

There is practically no relieving feature in this market. Makers of marked bars need considerably more work than is forthcoming at present, and their price is unaltered at £12 10s. at works. The makers of crown and the cheaper grades of iron are quite unable to secure sufficient tonnage to ensure regular operation, and part-time working is general in these mills. The price of crown iron of good make is £10 per ton, but in other cases crown iron is quoted at as low as £9 10s. Nut and bolt iron is at from £8 15s. to £9. The local mills secure a very small proportion of the available business for bolt iron, as the Continental product is so much cheaper. Belgian No. 3 is offered at as low as £4 15s. for good orders, and £4 17s. 6d. to £5 is offered freely for quite ordinary parcels.

Steel.

The demand for finished steel is unsatisfactory. Few of the works are operating at more than 50 per cent. of capacity, and the arrangement of rolling programmes is a source of continual anxiety. The shipbuilding industry provides a restricted outlet for plates and heavy sections, and the demand from other consuming trades show no improvement. The position of small steel bars is disappointing. The sheet trade is inactive, the demand for galvanised sheets, particularly, being still extremely poor. There is no sign yet of any improvement in semi-finished steel. The re-rollers are working at much below capacity and have difficulty in disposing of their products. Generally the demand for semis is restricted, and some low prices are being quoted from the Continent, where the situation is reported to be very difficult.

Scrap.

Little business is passing in the Cleveland iron and steel scrap market. At most of the works consumption is greatly reduced, and consumers are not tempted by the opportunity of acquiring cheap material. Ordinary quality cast-iron scrap is quoted at 48s. 6d., and good machinery quality at 51s. The scrap market is very quiet in the Midlands, but there is a rather more optimistic feeling prevalent. Good heavy machinery cast-iron scrap in cupola sizes is worth 57s. 6d. delivered, and light cast iron is at 37s. 6d. to 40s. In Scotland supplies are plentiful and the consumption limited. Consequently prices are easy. First-class machinery metal in pieces not exceeding 1 cwt. is at 53s. 6d. to 55s. Ordinary cast-iron scrap to the same specification is quoted at 50s. The above prices are all delivered consumers' works.

Metals.

Copper.—There has been an advance in the exporters' quotation of 25 points to 10.80 c.i.f., or £49 18s. 9d. in sterling, but buyers did not rally to the new price, and business has been rather slow in consequence. Standard reacted somewhat, and, for the moment, a check seems to have been given to the upward movement, but, on the whole, the outlook for copper is not unfavourable, and the general expectation is that a higher price will be seen before very long. The anticipated improvement in American industrial conditions is very slow in materialising, and conditions are not such as to provoke undue optimism as to a material improvement in the spring.

Closing quotations :—

Cash.—Thursday, £45 17s. 6d. to £46; Friday, £46 to £46 2s. 6d.; Monday, £45 8s. 9d. to £45 10s.; Tuesday, £44 13s. 9d. to £44 15s.; Wednesday, £44 16s. 3d. to £44 17s. 6d.

Three Months. — Thursday, £46 7s. 6d. to £46 8s. 9d.; Friday, £46 11s. 3d. to £46 12s. 6d.; Monday, £46 to £46 1s. 3d.; Tuesday, £45 5s. to £45 6s 3d.; Wednesday, £45 7s. 6d. to £45 8s. 9d.

Tin.—It may be some time before the quota scheme will make itself felt to any purpose in the statistical position, as it does not appear as if the proposed cut of 22 per cent. by the four chief producing centres will be sufficient to demolish the present stocks of surplus metal unless consumption revives beyond all expectations. It is possible that a yet more drastic cut may have to be made in order to gain the object of the producers. At the moment, although the sentiment of the market is better, stocks are very large, and consumption does not improve to any marked extent. Nevertheless it must be agreed that the future is more promising than it has been for a very considerable time.

Official closing prices :—

Cash.—Thursday, £121 10s. to £121 12s. 6d.; Friday, £122 10s. to £122 12s. 6d.; Monday, £123 2s. 6d. to £123 5s.; Tuesday, £122 2s. 6d. to £122 5s.; Wednesday, £122 2s. 6d. to £122 5s.

Three Months.—Thursday, £123 to £123 2s. 6d.; Friday, £124 to £124 5s.; Monday, £124 12s. 6d. to £124 15s.; Tuesday, £123 12s. 6d. to £123 15s.; Wednesday, £123 12s. 6d. to £123 15s.

Spelter.—Relaxed selling pressure, assisted by reduced liquidation, the comparatively low price and a restricted production, is responsible for the rather better appearance of the market at present. Sentiment is inclined to be uncertain, and it is impossible to say how long the slight improvement will be maintained.

Daily fluctuations :—

Ordinary.—Thursday, £12 16s. 3d.; Friday, £12 16s. 3d.; Monday, £12 12s. 6d.; Tuesday, £12 7s. 6d.; Wednesday, £12 5s.

Lead.—The recent improvement in buying seems to have been checked, and the demand from consumers has been variable during the week. There has, however, been no pressure on the part of holders to sell.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £14 2s. 6d.; Friday, £14 2s. 6d.; Monday, £13 17s. 6d.; Tuesday, £13 10s.; Wednesday, £13 8s. 9d.

A report from Glasgow states that a petition has been presented to the First Division of the Court of Session by the Clydesdale Bank for the winding-up of Messrs. Merry & Cuninghame, Limited, and for the appointment of an official receiver.

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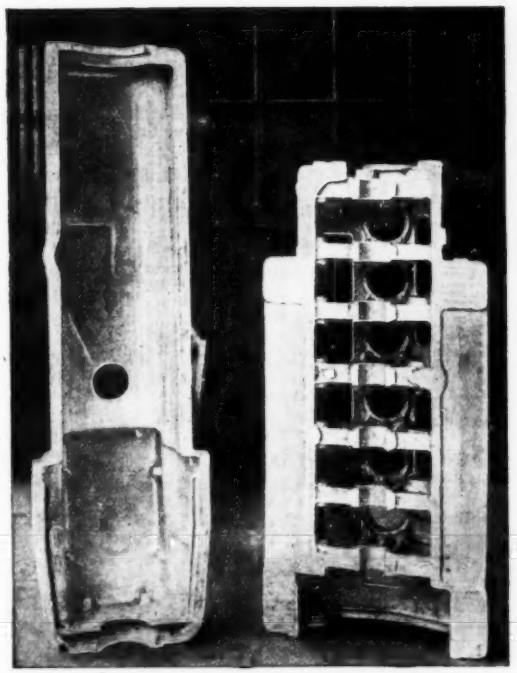

Top and bottom halves of a marine engine crankcase, cast in aluminium by William Mills, Ltd., Birmingham. (Photo by courtesy of John I. Thornycroft & Co., Ltd.)

To the good casting properties of light aluminium alloys must be added speedy and economical machining—important advantages in producing the bulky castings of marine engineering. The founder benefits; so does the marine engineer because the first result of weight reduction is that for a definite weight of cargo the ship is not so deeply immersed, and thus running costs are lowered. But the vital point with ships whose carrying capacity is set by the Plimsoll mark is that lightness in the vessel itself means a direct increase in the cargo carrying capacity.

Write for booklet No. 317, "Aluminium in Marine Construction."

Light Alloys of Aluminium

THE BRITISH ALUMINIUM CO., LTD.

ALUMINIUM PRODUCERS. ADELAIDE HOUSE, LONDON, E.C.4.

'Phone: Mansion House 5561 & 8074. 'Grams: Cryolite, Bilgate, London.

F.T.J. 12. 3. 31.

Special CARBON BLACKING

67 YEARS EXPERIENCE. MADE BY A FIRM WITH

JAS. DURRANS & SONS. LIMITED.

PHŒNIX WORKS PENISTONE. NR. SHEFFIELD.

Also—

GANISTER, LOAM AND SAND MILLS.

STUDS, CHAPLETS, BRUSHES, CORE ROPES, BUCKETS, SPADES, ETC. LADLES, FIRE BRICKS, STONE FLUX, CASTING CLEANERS, PIPE NAILS, SPRIGS, WIRE BRUSHES, BELLOWS.

PLUMBAGO

CORE GUM

WHITE DUST

COAL DUST

REQUISITES

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	44	16	3
Three months	45	7	6
Electrolytic	48	0	0
Tough	45	5	0
Best selected	45	15	0
Sheets	77	0	0
India	58	0	0
Wire bars	49	18	9
Do., April	49	18	9
Do., May	49	18	9
Ingot bars	49	18	9
H.C. wire rods	51	0	0
Off. av. cash, February	45	8	3¾
Do., 3 mths., February	45	6	1½
Do., Sttlmnt., February	45	8	1½
Do., Electro, February	48	4	4½
Do., B.S., February	47	5	0
Do., wire bars, February	48	9	9
Solid drawn tubes			11d.
Brazed tubes			11d.
Wire			7d.

BRASS.

Solid drawn tubes	9¾d.
Brazed tubes	11¾d.
Rods, drawn	9¾d.
Rods, extd. or rlld.	5¾d.
Sheets to 10 w.g.	8¾d.
Wire	8¾d.
Rolled metal	7¾d.
Yellow metal rods	5¾d.
Do. 4 × 4 Squares	6d.
Do. 4 × 3 Sheets	6¾d.

TIN.

	£	s.	d.
Standard cash	122	2	6
Three months	123	12	6
English	123	15	0
Bars	125	15	0
Straits	125	2	6
Australian	123	12	6
Eastern	126	12	6
Banca	125	2	6
Off. av. cash, February	118	0	0¾
Do., 3 mths., February	119	9	3
Do., Sttlmt., February	118	0	3

SPELTER.

	£	s.	d.
Ordinary	12	5	0
Remelted	11	10	0
Hard	9	5	0
Electro 99.9	14	12	6
English	12	15	0
India	10	10	0
Zinc dust	20	0	0
Zinc ashes	3	0	0
Off. aver., February	12	9	11½
Aver. spot, February	12	6	0¾

LEAD.

	£	s.	d.
Soft foreign ppt.	13	8	9
English	14	15	0
Off. average, February	13	9	11¼
Average spot, February	13	8	10½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	21	0	0
Do., V.M. ex-whf.	20	5	0
Rods	23	10	0
Boiler plates	14	7	6
Battery plates	16	5	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	36	0	0
Chinese	24	15	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 7 6
45/50%	£11 5 0
75%	£18 0 0
Ferro-vanadium—	
35/40%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 15 0
Ferro-tungsten—	
80/85%	2/- lb.
Tungsten metal powder—	
98/99%	2/3 lb.
Ferro-chrome—	
2/4% car.	£29 17 6
4/6% car.	£21 0 0
6/8% car.	£20 15 0
8/10% car.	£20 10 0
Ferro-chrome—	
Max. 2% car.	£31 15 0
Max. 1% car.	£35 0 0
Max. 0.70% car.	£37 2 6
70% carbon-free	10d. lb.
Nickel—99% £170 0 0 to	£175 0 0
Ferro-cobalt	9/2 lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£11 0 0
76/80% packed	£12 0 0
76/80% export	£10 0 0
Metallic manganese—	
94/96% carbonless	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{7}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales							
Heavy steel					2	7	6
Bundled steel and shrngs.	1	17	6	to	2	2	6
Mixed iron and steel	1	17	6	to	2	0	0
Heavy cast iron	2	8	0	to	2	9	0
Good machinery for foundries					2	10	0
Cleveland—							
Heavy steel	2	5	0	to	2	6	0
Steel turnings					1	10	0
Cast-iron borings					1	5	0
Heavy forge					2	15	0
W.I. piling scrap					2	11	6
Cast-iron scrap	2	8	6	to	2	11	0
Midlands—							
Light cast-iron scrap					1	17	6
Heavy wrought					3	0	0
Steel turnings						—	
Scotland—							
Heavy steel					2	5	0
Ordinary cast iron					2	10	0
Engineers' turnings					1	15	0
Cast-iron borings					1	13	6
Wrought-iron piling					2	15	0
Heavy machinery					2	13	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	38	0	0
Brass	27	10	0
Lead (less usual draft)	12	0	0
Tea lead	9	0	0
Zinc	6	10	0
New aluminium cuttings	50	0	0
Braziery copper	35	0	0
Gunmetal	36	0	0
Hollow pewter	76	0	0
Shaped black pewter	56	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	68/6
Hematite M/Nos.	68/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	75/6
,, d/d Birm.	86/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs common*	—
,, No. 4 forge*	66/-
,, No. 3 fdry.*	71/-
Shrops basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	62/6
,, fdry. No. 3*	67/6
,, fdry. No. 1*	70/6
Derbyshire forge*	66/-
,, fdry. No. 3*	71/-
,, fdry. No. 1*	74/-
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	76/-
,, No. 3	73/6
Hem. M/Nos. d/d	74/-
Sheffield (d/d district)—	
Derby forge	61/-
,, fdry. No. 3	66/-
Lincs forge	—
,, fdry. No. 3	66/-
E.C. hematite	81/6
W.C. hematite	84/6
Lancashire (d/d eq. Man.)—	
Derby forge	64/6
,, fdry. No. 3	69/6
Staffs fdry. No. 3	69/6
Northants fdry. No. 3	68/-
Cleveland fdry. No. 3	71/
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	90/- to 91/-
Glengarnock, No. 3	—
Eglinton, No. 3	90/- to 91/-
Gartsherrie, No. 3	90/- to 91/-
Monkland, No. 3	90/- to 91/-
Shotts, No. 3	90/- to 91/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	10	0	0	to	10	10	0
Nut and bolt iron					8	15	0
Hoops	10	15	0	to	12	0	0
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip	10	15	0	to	12	0	0
Bolts and nuts, ¾ in. × 4 in.					14	5	0
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	9	5	0	to	10	5	0
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¾ in. (Untested)	7	5	0	to	7	15	0
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates					12	0	0
Hoops (Staffs)	9	5	0	to	9	10	0
Black sheets, 24g.	8	10	0	to	9	10	0
Galv. cor. shts. 24g.					11	0	0
Galv. flat sheets					11	10	0
Galv. fencing wire, 8g. plain					12	0	0
Billets, soft	5	5	0	to	5	12	6
Billets, hard	7	2	6	&	up.		
Sheet bars	5	0	0	to	5	12	6
Tin bars	5	0	0	to	5	12	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/-
Sheet to 10 w.g.	1/0½
Wire	1/1¼
Rods	1/-
Tubes	1/7
Castings	1/-

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/- to 10 g.	1/4½ to 1/11½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.76
No. 2 foundry, Valley	16.50
No. 2 foundry, Birm.	13.00
Basic	18.26
Bessemer	18.76
Malleable	18.76
Grey forge	17.76
Ferro-mang. 80%	80.00
O.-h. rails, h'y, at mill	43.00
Billets	30.00
Sheet bars	30.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.65
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.60
Skelp, sheared steel	1.60
Steel hoops	1.90
Sheets, black, No. 24	2.35
Sheets, galv., No. 24	2.90
Sheets, blue an'l'd, No. 13	2.05
Wire nails	1.90
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/-
,, furnace	15/- to 17/-
Durham and Northumberland—	
,, foundry	13/6 to 14/-
,, furnace	13/6
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	15/3 to 15/6
,,	28×20 ,,	31/-
,,	20×10 ,,	22/9
,,	18¾×14 ,,	16/3
C.W.	20×14 ,,	15/-
,,	28×20 ,,	29/6
,,	20×10 ,,	21/-
,,	18¾×14 ,,	16/-
Terneplates	28×20	31/- per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars and rods dead soft, st'l	£11 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ⅛ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Mar.	5 ..	45	17	6	dec. 10/-
,,	6 ..	46	0	0	inc. 2/6
,,	9 ..	45	8	9	dec. 11/3
,,	10 ..	44	13	9	,, 15/-
,,	11 ..	44	16	3	inc. 2/6

Electrolytic Copper.

		£	s.	d.	
Mar.	5 ..	49	5	0	dec. 2/6
,,	6 ..	49	5	0	No change
,,	9 ..	48	10	0	dec. 15/-
,,	10 ..	48	0	0	,, 10/-
,,	11 ..	48	0	0	No change

Standard Tin (cash).

		£	s.	d.	
Mar.	5 ..	121	10	0	inc. 2/6
,,	6 ..	122	10	0	,, 20/-
,,	9 ..	123	2	6	,, 12/6
,,	10 ..	122	2	6	dec. 20/-
,,	11 ..	122	2	6	No change

Tin (English ingots).

		£	s.	d.	
Mar.	5 ..	123	0	0	No change
,,	6 ..	124	0	0	inc. 20/-
,,	9 ..	124	15	0	,, 15/-
,,	10 ..	123	15	0	dec. 20/-
,,	11 ..	123	15	0	No change

Zinc Sheets (English).

		£	s.	d.	
Mar.	5 ..	21	0	0	No change
,,	6 ..	21	0	0	,, ,,
,,	9 ..	21	0	0	,, ,,
,,	10 ..	21	0	0	,, ,,
,,	11 ..	21	0	0	,, ,,

Spelter (ordinary).

		£	s.	d.	
Mar.	5 ..	12	16	3	dec. 1/3
,,	6 ..	12	16	3	No change
,,	9 ..	12	12	6	dec. 3/9
,,	10 ..	12	7	6	,, 5/-
,,	11 ..	12	5	0	,, 2/6

Lead (English).

		£	s.	d.	
Mar.	5 ..	15	10	0	No change
,,	6 ..	15	10	0	,, ,,
,,	9 ..	15	5	0	dec. 5/-
,,	10 ..	14	15	0	,, 10/-
,,	11 ..	14	15	0	No change

AVERAGE MONTHLY PRICES OF IRON HOOPS.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 5 0	6 10 0	6 3 0
1897	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 8
1898	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	7 0 0	6 11 6
1899	7 0 0	7 0 0	7 0 0	7 0 0	7 12 6	10 12 6	8 12 6	8 12 6	8 12 6	9 2 6	9 7 6	9 17 6	8 2 9
1900	9 17 6	10 7 6	10 7 6	10 7 0	10 12 6	7 12 6	10 12 6	10 12 6	10 12 6	9 17 6	9 2 6	9 2 6	10 3 8
1901	9 2 6	8 2 6	8 2 6	7 12 6	7 12 6	7 12 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 11 2
1902	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1903	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 0
1904	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1905	6 17 6	7 0 0	7 0 0	7 0 6	7 0 0	7 0 0	7 2 6	7 2 6	7 2 6	7 7 6	7 0 0	7 7 6	7 2 0½
1906	7 10 0	7 17 6	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 7 6	7 15 1½
1907	8 7 6	8 7 6	8 7 6	8 7 0	8 7 6	8 7 6	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 0 0	8 7 1
1908	8 0 0	7 10 0	7 10 0	7 10 6	7 10 0	7 10 0	7 10 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 6 8
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
1910	7 1 10½	7 6 3	7 7 6	7 7 0	7 7 6	7 7 6	7 7 6	7 7 6	7 7 6	7 6 3	7 5 0	7 5 0	7 6 5
1911	7 5 0	7 5 0	7 5 0	7 5 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 8 9	7 10 0	7 10 0	7 6 2½
1912	7 12 6	7 12 6	7 12 6	7 15 0	7 15 0	8 2 6	8 2 6	8 2 6	8 12 6	8 12 6	8 12 6	8 15 0	8 2 3½
1913	8 17 6	8 17 6	8 17 6	8 17 0	8 17 6	8 17 6	8 17 6	8 7 6	8 7 6	8 7 6	8 7 6	7 17 6	8 12 6
1914	7 17 6	7 17 6	7 17 6	7 13 9	7 12 6	7 12 6	7 12 6	9 2 6	9 2 6	9 2 6	9 2 6	9 2 6	8 6 4½
1915	9 3 6	9 18 1	10 7 6	10 16 6	10 17 6	13 2 6	13 2 6	13 2 6	13 7 6	14 2 6	15 2 6	15 18 6	12 10 1
1916	17 2 6	17 2 6	17 2 6	17 6 3	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 6 1
1917	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1918	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1919	17 2 6	17 2 6	17 2 6	17 2 6	24 6 3	24 6 3	24 6 3	25 9 0	26 7 6	26 7 6	26 7 6	26 17 4	22 14 9
1920	28 0 0	28 12 6	33 15 0	35 5 0	35 15 10	38 17 6	38 17 6	38 17 6	38 17 6	38 17 6	36 17 6	36 17 6	35 14 9
1921	29 1 3	23 5 0	21 12 6	20 0 0	20 0 0	20 0 0	17 5 0	15 0 0	14 4 0	13 15 0	13 10 0	12 18 0	17 5 10
1922	16 5 0	15 13 9	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	13 4 6½
1923	14 0 0	15 0 0	15 0 0	15 0 0	15 6 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 16 0	14 15 0	14 18 3½
1924	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 13 9	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 12 4½
1925	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1926	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	12 10 0	12 10 0	14 3 4
1928	12 10 0	12 7 6	12 0 0	11 13 6	11 15 0	11 12 6	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 14 10½
1929	11 10 0	11 10 0	11 10 0	11 10 0	11 9 0	11 5 0	11 5 0	11 5 0	11 5 0	11 2 0	11 0 0	11 0 0	11 5 11
1930	11 0 0	11 0 0	11 0 0	10 16 3	10 15 0	10 15 0	10 15 0	10 15 0	10 15 0	10 15 0	10 15 0	10 15 0	10 16 4½
1931	10 15 0	10 15 0	—	—	—	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

LIMPET

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

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(A remittance should accompany instructions.)

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FOREMAN, experienced, wanted for Iron and Non-Ferrous Foundry near London; state previous experience, time at each, references. None but first-class men need apply.—Box 758, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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